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Chapter 3

Sustainable Development & Spatial Planning

The regulatory framework in urban biogas plants realization to define new steps for a Common development of regulatory guidelines in EU member States

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Abstract. The importance of renewable energy exploitation is a main topic in European Union since the 2001/77/CE Directive publication, reaffirmed with the Directive 2009/28/CE on promotion of the use of energy from renewable sources. Among the renewable energy sources, biogas is getting its space. Indeed Community has underlined the biogas role in 2006/208/CE Regulation, through the Community Resolution on biogas of 12 March 2008, and finally with the European Directive 2009/28 which restates the importance of biogas as renewable source for environmental advantages in terms of heat and power production. Especially the biogas urban nature concerns other European rules as the waste directive 2008/98/CE. Despite European guidelines, national independent receptions have generated several biogas regulations which have created different countries conditions to the biogas plants development. Nowadays few studies on European biogas regulatory are available. Authorizations, waste chain management, public incentives, emissions limits have been programmed and developed differently State by State, producing an irregular biogas diffusion in European Community.

1. INTRODUCTION

The development of new Energy Efficiency practices, as fixed by 2020 EU guidelines towards the "20-20-20" European targets, has to be supported by a clear regulatory framework. Its aim is to prepare a full involvement of new energy solutions, so to achieve European strategies related to Renewable Energy Sources (RESs) promotion and Greenhouse Gas (GHG) reduction; biogas is one of the most complex RES to run. Because of its technological complexity the biogas regulatory framework has to challenge various laws usually not related to the most diffused RES.

This paper wants to be a contribute in the analyze of biogas regulatory framework in European countries where these RESs are a meaningful part of the energy market constantly increasing since the start of 21st century. This work tries to better understand the regulatory conditions which contribute, or obstruct, biogas development and diffusion with the aim to define a first step towards new common guideline inside Community. The paper choice is to consider urban biogas plants, so to include consideration on waste exploitation and related regulatory, being an additional contribution for the development of biogas plants in urban areas, nowadays still marginal rather than rural plants.

The first part of this paper will describe the EU regulatory framework, through the directives' subjects and the guidelines established in the last years. The second part will focus the attention on national directives' acceptances and composition of regulatory instrument for the biogas development; this part will research among the national laws in relation with biogas state of art and its development in next years comparing adopted solutions. The last part will define possible steps towards the definition of communitarian strategies for biogas development through regulatory framework.

2. BIOGAS IN EU REGULATORY: INTRODUCTION TO COMMUNITARIAN REGULATORY

The advancement of new technologies and the emerging topic of energy efficiency and sustainability is one of the meaningful issue in the European Union debate. Since the starting of this century, EU has started to focus its attention in the development of energy policies able to contribute for a deep transformation in the Community; the whole EU regulatory framework has been created to accomplish the conditions for a new sustainability concept, based on environmental, economic and social implementation. This climate and energy package of binding legislation has to ensure EU meets 2020 energy targets; biogas is part of this scenario.

Although the 2009/28/EC Directive defines biogas as a RES, its urban application is difficult. Despite biogas and anaerobic digestion are known for centuries and the technology is not complex, the biogas difficulties depend on various aspects, involving many EU regulatory authorities. Whereas the most of RESs depend primarily on two directives, the Energy Directive 2009/28/EC and Energy Taxation Directive 2003/96/EC, biogas needs to afford at least the Waste Directive 2008/98/EC and the Fertilizer Regulation 2003/2003; here there is the biogas intricacy. The need to relate different policies and regulatory is primary to better understand biogas regulatory potential.

2.1. *Biogas and Eu framework Policies*

Development of biogas cannot be successful without clear and working Community Policies. Nowadays the main barrier is represented by old and improper Directives guidelines, overall the Directive 2003/96/EC on Energy Taxation, to be upgraded and changed towards new objectives. The need to review biogas EU framework has been underlined by the European Parliament with the Resolution of 12 March 2008. Although it focused the attention on biogas in agriculture, the resolution highlighted the biogas potential, underlining the environmental and the economic importance to guarantee financial viability and adequate support schemes so to achieve biogas installation operators to combine and use all available organic matters. The Resolution outlines the actions needed to evolve this potential: EU legislation urges to develop a coherent biogas policy to underline the necessary changes in Community and national laws so to point out the most efficient ways of using EU funds and programs.

The Directive 2003/96/EC on Energy Taxation is without any doubt the one that need the huge improvements. Although the Commission recognizes the need to modernize EU rules on energy taxation, restructuring the taxation of energy products, in order to remove current imbalances and distortions and support the EU's wider environmental and energy goals, the proposed revision of 2011 was withdrawn by the Commission in 2015, because of the unsuccessful negotiations with EU Member States. The Energy Tax Directive was born to guarantee common rules in EU Energy market so to safeguard the Energy competitiveness, imposing a tax minimum level throughout flexibility instruments that achieve to each Member State to define and implement peculiar policies to own national circumstances, but without having a perspective of further development in Renewable Energy sector and in the latest EU programs on RESs development. Although the The Energy Tax Directives needs a review, it forecasts the development of environmental dispensations and promoted the use of Combined Heat and Power (CHP) generation in order to promote use of alternative energy.

The Waste Directive 2008/98/EC offers another suggestion to define biogas application in urban district; bio-waste in urban biogas plant is the main matter for energy production. Indeed urban biogas can be a technical, environmental and economical efficient measure to achieve high quality standards in waste collection as required by the Directive. As predicted by the Waste Directive, Member States should promote the separated collection of bio-waste with a view to composting and digestion, part of biogas production, so to achieve an high level of environmental protection through the treatment of bio-waste; the result is not only avoiding land filling, but reaching energy efficiency thanks to biogas production and utilization. In addition to these addresses, biogas from waste can encourage policies based on citizens sensitivity in order to prepare for waste re-use, waste energy recover, decrease waste disposal, all parameters required by the Waste Directive for waste hierarchy.

2.2. Support schemes: taxation and incentives

One of the most important voice in biogas system diffusion is represented by the financial and economical support schemes established by each Member State. Indeed Parliament Resolution 12/03/2008 affirms that an adequate subsidies or other economical measures are the most successful in promoting biogas until the biogas sector could become commercially viable. The support schemes based on incentives and subsides established by Member States during these last years have increased biogas and RESs diffusion instead of traditional fossil fuel. Fundings are basic to increase *green electricity* and *green gas* so to research, develop and promote specific projects with this aim. In the mentioned Resolution, CHP is recognized as one of the strategic technology towards biogas energy exploitation so that it should have fundings guaranteed to be invested in the most efficient and sustainable installations; CHP generator importance is underlined in Energy Taxation as mentioned.

The Energy Tax Directive 2003/93/EC is the one that is actually responsible for part of biogas utilization cost. In art. 4 the Directive establishes a total level of taxation levied in respect of all indirect taxes (except VAT) calculated directly or indirectly on the quantity of energy products and electricity at the time of release for consumption. If the Directive article is quite clear, it is not for national applications where the Directive aim is not respected for two causes. The first is Member States' taxes generated differently by central and local authorities, that create very complex scenarios for consumers and for enterprises. The second problem is represented by some States' dependence on energy import, as primary sources or as usable energy. The result is having Countries with higher energy costs than the EU average so to create advantageous or disadvantageous energy market conditions. Energy Tax Directive offers to Biogas a way to overcome this energy difficulties. In fact art.14 predict for total or partial fiscal exemptions, or taxation reduction, for pilot projects, for technological development of environmental products, for electricity generated from biomass – one of the matter for biogas production, or CHP generation. In this way the taxation can be controlled and decreased for virtuous environmental project, as long as to be refunded (art.15) if produced by biomass.

2.3. Authorizations and plans

The complexity of the authorization procedure is still one of the major obstacles to the increase in use of renewable sources. Despite European Parliament recognizes that Member States' support schemes should draw attention not to create unnecessary hindrance trough their approval procedures, regional planning, granting of license and approval schedule, much is still to do. Member States' support schemes should call for simplified planning permission procedures in biogas construction installations, but nowadays simplification is restricted too often to exceptional cases of “*urgent works in the public interest*", as provided for Italian Legislative Decree No. 387/2003.

In addition to b*iogas p*lant energy production authorization, urban biogas challenges the waste management approval too. In fact art.16 of Waste Directive 2008/98/EC compels Member States to take appropriate measures to establish an integrated and adequate network of waste disposal installations and of installations for the recovery of mixed municipal waste collected from private households, including where such collection also covers waste from other producers, taking into account the best available techniques. Bio-waste district exploitation could achieve to improve environmental measures for re-use, recycling, recovery of waste, in order to support the implementation of the Directive's objectives (art.28), and to exempt from disposal permit in case of disposal of at the place of production for waste recovery (art.24).

2.4. *Cooperation and participation*

A final stressed point is the role of cooperation, considered a meaningful part of biogas urban development. Indeed the development of a biogas plant inside the urban context can not excluded a strict debate with citizens and local actors. Also the Commission highlights with art.31 of Waste Directive that Member States should ensure the opportunity to participate in the elaboration of the waste management plans especially if these have relevant environmental effects; urban biogas has to go though cooperation. The European Parliament asks for something more. In fact with the mentioned Resolution, the Parliament asks for support schemes able to encourage farmers cooperation in biogas production; if the speech is efficient for farmers, it can be more significant for district and its actors too. From the district scale, also the cooperation among Member States is underlined by the Resolution; indeed for the Parliament, EU legislation needs to ensure cooperation and collaboration between Member States, to learn about each other best practices and export efficient biogas models.

3. NATIONAL ACCEPTANCE

The EU Countries have a huge potential for biogas development. Agriculture products, animal manure, water treatment and, in urban scenario, bio-waste offer a widespread sources for biogas national energy production so that each Member States could develop biogas plant depending on their typical feedstock. Considering feedstock a source present in each EU Countries with its peculiarity, biogas is not developed and exploited in the same way for the restraints given by the uncertainties of the regulatory framework. Indeed its production and utilization depends on national policies, incentives, subsides, authorizations, all aspects that create the national framework for biogas appliance, important part for its development in RESs scenario, to impede or allow its improvement.

Under the Energy Efficiency Directive 2012/27/EU, each Member State has established binding national targets for raising the share of renewable energy in gross energy consumption. The aim is to achieve the EU targets by 2020, using National Energy Efficiency Action Plans – NEEAPs as regulatory framework, a set of policies dependent on national renewable energy benchmark and final targets; biogas is part of these NEEAPs. In fact it represents a potential in a range of 170Mtoe/yr and 235Mtoe/yr in Europe and can be developed by each Countries with precise policies. Biogas as renewable electricity and as heat energy thanks to co-generation, can contribute to the increase of the RES share in EU energy mix. In addition, biogas represents the opportunity for many EU Countries to decrease the energy dependence on natural gas. Indeed biogas can be used in almost all the applications that are developed for natural gas and for the other it has to be upgraded, so to be injected directly into the natural gas grid. Biogas is an opportunity and Member States have grabbed it in their Energy Plans. Whereas in some countries biogas already provides more than 5%, 2300 MW of the total electricity demand like in Germany, Member States like Spain or eastern Countries like Romania and Hungary, have an enormous potential to exploit biogas through national acceptances of EU Directives and to promote central policy or separate plan proposing specifically measures.

The following paragraphs will review EU Countries' existing framework throughout their national policies, incentives, subsides predicted and authorizations needed for biogas plant realization.

3.1. *National Policies' Strategies*

Biogas can represent a double opportunity in national scenarios; despite the EU regulatory framework focuses on electricity production as primary energy source, the demand for heat consumes is the largest share of the primary energy supply. Biogas can be a solution for a sustainable co-generation and many EU Countries have created national policies and strategies for biogas exploitation and its promotion as in Germany, where biogas is playing a key role in the strategy to reach a share of RESs of 20% in the final energy consumption and of 35% in the electricity sector by 2020, in Finland where through the Finnish national action plan is predicted to account for at least 20% of renewable transportation fuels, or Denmark experience where in particular the Danish government has created a Biogas Task force to monitor the expansion of biogas, to support specific projects and suggest for additional initiatives. The aims are different: providing base load electricity, as valuable option to balance other RES energies more fluctuating like wind power and photovoltaic, injecting a cost competitive biogas into the grid, replacing natural gas and its import, especially in decentralized CHPs, or having a sustainable fuel for transportation.

Not all Member States have biogas policies; while small Countries like Malta or Cyprus prefer to invest in more efficient and less expensive RES for their dimension, as for Photovoltaic, other Countries like Czech Republic or Sweden have not policies proposing specific measures for biogas. Despite the lack of biogas policies, in this scenario some Country as Hungary entrusts a crucial role to the biodegradable fraction of land filled municipal solid waste. In fact accepting 1999/31/EC Directive on landfills disposal the biodegradable part of municipal solid waste can be used as biomass in biogas plant so to reduce the amount of land filled waste and also to limit the CO_2 emission. As for lack of policies, another pitfall is represented by uncertain policies, especially connected to uncertainty of incoming budget; Sweden is an example. Despite a very noticeable Renewable Energy sector the current subsidy situation is an obstacle, stopping the biogas development, only minimally reduced thanks to transportation fuel policies, related especially to biogas upgrade and tax exemption.

There is not a perfect national framework, because it depends on financial resources, economic interests, local culture and sustainable attitudes. The single lacks are different: not coherent policy framework regulating the biogas sector as in Italy, where the decree No. 28/2011 can be considered the only legislative act for entire sector of RES' electricity production; biogas for heat is not directly supported, despite it is considered eligible to be used for new house as renewable heat obligation law as in German; creditor difficult to find as in Hungary; green certificate price set by market and not fixed by legislation as in Sweden; absence of further policies development after a certain date as in Sweden or in Italy; long procedure for authorization; complicate incentivisation systems.

3.2. Support schemes: taxation and incentives

In last years many different support schemes have been issued in order to promote biogas and the gross scenario of RESs. The cost for biogas production is not yet competitive with traditional fuels, depending on feedstock used, technologies applied, plant size, so Member States have issued national support schemes based primary on financial incentives and tax exemption. In the Table 1 is possible to have a look on Member States' adopted incentives measures.

The most diffused instruments are Feed-in-tariff (FIT) and Premium-tariff (PT). In fact as shown in 'table 1', among the 28 actual, 16 Member States have FIT, 8 Member States have PT only 5 Member States – Belgium, Cyprus, Malta, Romania and Sweden - have neither FIT, neither PT. Many Countries have adopted FIT because PT is demonstrated to provide higher total payments than FITs. Whereas FIT has an energy price issued to cover the biogas energy production, independent of energy market spot, the aim of PT policy is offering a premium above the average spot electricity market price in order to address the environmental strategy of RE generation, or to better approximate renewable energy generation costs. This is in contrast to the FIT approach, where a purchase is typically guaranteed so to keep the renewable energy generation separate from spot market fluctuation. Some Member States offer both a FIT and a PT option, so that producers can choose for electricity tariff in order to meet enterprises financial needs. FIT and PT needs a guaranteed incentivisation period, different Country by Country, from 10 years to 20 years. In addition to these tariffs there is an interesting extra incentive adopted in Finland to promote investments on CHP through biogas.

Table 1. Biogas EU Member States national policies. MS – Member State, FIT – Feed-in-tariff, PT – Premium Tariff, SUB – Subsidies, QS – Quota System, L – Loan, NM – Net Metering, Tax, CfD – Contract for Difference.

MS	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
FIT	•		•			•			•			•	•	•	•	•	•	•	•				•			•	•	•
PT						•	•	•		•	•					•					•					•		
SU	•	•				•	•	•	•		•	•					•	•				•		•		•	•	
QS		•																				•		•	•			•
L			•			•			•				•				•					•				•		
NM		•					•							•		•			•		•							
Tax		•			•				•							•	•		•		•	•			•		•	•
CfD																												•

Feed-in-tariff and Premium-tariff do not concern all plants. In fact among the possible incentives, the are other financial systems based on subsidies systems, financial policies that guarantee incomes for covering designing, commissioning, installation costs, depending on State or local funds issued by each Government related to specific period. The period predicted for funds represents the main problem. In fact the large part of Member States have annual funds, established by yearly financial programs, an obstacle for enterprises. In fact it is more favorable to offer a subsidy framework self-assured and steady in the long period budget, as issued in Poland, or Romania for 7 years.

One of the system thought to promote biogas is RESs Quota-system. The idea was to produce a certain amount of green electricity certificates established by Countries' Governments so to achieve Renewable Energy target issued by EU Directive. The main problem with quota System is the price for the green certificates usually determined by the market so to fluctuate over time and only green certificate with price fixed by legislation could represent a safe investment for energy suppliers.

Among the incentives, one of the most important support is represented by the grid priority access. In fact thanks to Net metering the RESs' energy produced can be priority injected in grid and receive the same quota produced for free. Some hints exist among the Member States, as in Flanders, Belgium, where the energy fed into the grid and not taken back, is not reimbursed, or in Italy where the exceeding energy is remunerated; someone else like the Netherlands has to pay a grid use charge.

In this scenario an important role could be the definition of loan schemes. In fact rarely an enterprise has the cash flow for realizing a biogas plant so to oblige for a bank loan with loan interests subject to free market. Despite private bank system, some Member States throughout their national bank promote loan to realize biogas plant so to promote sustainable targets and international goals through loan system with low interests guaranteed by national funds.

An absolute innovation in support scheme context is the Contract for Difference - CfD. Emanated by UK Government is a private law contract between a RES generator and a Low Carbon Contracts Company - LCCC, owned by the UK Government. The CfD is based on a difference between the market price and an agreed “strike price” and the payment of this difference to the contractor with the payable credit. The efficiency of this support scheme need to be testified during next years to understand if it can increase RES and biogas scenario, following the sole rules of free market.

In addition to the different incentives schemes over mentioned, another important instrument is the taxation. In fact Member States are free to set their own national taxes. Energy taxes are part of the budgetary policies of each Countries, free to set rules on what should be taxed, when and what exemptions are allowed. Taxation role can be a persuasive instrument in order to influence consumer behavior or promote certain political, social and cultural aims. In fact taxes applied in fossil fuels affects citizens behaviors and can be considered an indirect subsidy for green energy development. Countries as Sweden, Finland, Denmark, Ireland have carbon tax in place.

The energy tax exemption could be fulfilled by waste taxation. The Swedish example is meaningful. A landfill tax has been introduced with the result of a progressive reduction of land filling and the complementary raise of recycling; biogas from household waste could take advantage of a policy of this type. Nowadays in spite of diffused recycling practices, there are not economical incentives or penalties so that a huge part of waste is still land filled with a great lost of energy that organic fraction of waste could generate.

3.3. Authorizations and plans

Efficiency standards, environmental impact, pollution limits, noises and odors emissions, strictly depending on national, regional or local rules contribute to create a complex scenario in authorization processes, so to be often a bureaucratic trap and a limit for biogas development.

The examples are multiples. In some Countries like Denmark, municipalities have to lay down specific areas for the construction of biogas plants, difficult to locate for social and cultural barriers, in other, the plants have to be processed and approved independently by local and regional authorities.

The result is a long authorization process. The approval period for biogas plants, from documents preparation to the ending final approval, depends on plant size, on authorities' skilled personnel, workload and local conditions. In spite of some exceptions as in Germany where the time approval of biogas plants by authorities is considered adequate (3 months for biogas plant up to 500kW and 5 months for biogas plants with an electric capacity over 500kW) in the greater part of EU Member States the authorization time is a barrier for biogas development with average time of 12/20 months. In Hungary the time-scale for projecting and licensing biogas plants is twice or even three times longer than the plant construction itself. The authorization process guarantees a whole control of projects, but it risks slowing down the investments. For these causes Member State are predicting some exceptions to shortcut authorization processes as issued in Italy, especially for plant up to 250kW.

In addition to authorization time approval, the biogas plant have to challenge with the coming neighbours. In fact people are worried regarding odors, noises, safety having a biogas plant in the backyard, and distance has a central importance; it is therefore important to inform on the planning process, especially in an urban biogas plant where the citizens are part of biogas production.

4. CONCLUSION

Regulatory framework is fundamental to achieve to develop urban biogas in district area. The analyze of the EU regulatory frameworks allows to define good practice and address to issue more efficient policies and support schemes. It is possible to identify two levels of actions for the development of urban biogas plants.

The first level acts on the European Community scenario where EU can propose a primary framework to address national policies towards urban biogas promotion, especially promoting practical solutions to achieve new energy targets and create the condition to have aware citizens. The action could be the definition of specific guidelines based on national policies, support schemes, authoritative processes experiences in order to identify the best economical, environmental and social solutions applicable to the various contexts of the member Countries. The aim will be to align existing policies and, at the meantime, to transfer the experiences among the Countries.

This anyway could not be enough without a contemporary revision of the existing Energy Tax Directive. As a matter of fact taxation is an indirect incentive towards the promotion of biogas, through the taxation of traditional fossil fuel with the introduction of new taxes based on CO2 emission and energy content. In addition the Directive should identify European tax to dissuade public and private waste producers to landfill, in spite of promoting energy efficiency use of bio-waste. The aim will be to guarantee the promotion of those resources able to generate alternative energy with low CO2 emissions and high energy content. Coming to the essential second promoting action, it’s clear that if EU could attend with general rules, national Governments and Parliaments have on the other hand a huge responsibility and effort to do. Whether Member States believe in RESs and biogas, they have primary to create the conditions to have competitive energy sources in their market. For this reason they should provide long-term budgetary plan; considering that European research programs and some Countries have 7 years long scheduled, this could be the address so to definite period for budget able to allow long period investments, and overcoming the uncertainty of unknown future economic resources both for public municipalities both for private enterprises. The incentives schemes should promote the innovative solutions that can optimize biogas and energy production, as for co-generation and tri-generation.

In the same way Member States should guarantee stability and long-term certainty for support schemes and regulatory framework conditions too. An overly alterable national framework discourages investments and energy innovations, and it is due exactly to the absence of a common and shared vision. Each Country accordingly should work to identify the most possible shared framework.

Strategically an important part could be covered by a more careful waste collection. Waste is business for management, disposal or incineration, and a cost for producers. The extended introduction of incentives in recycling activities could diffuse recycling practices, recovering the waste nowadays land filled and saving the energy that organic fraction of waste could generate. Member States should promote actions to allow that householders, economical activities or industries could collect and separate waste being aware of their contribution in waste prevention and energy production. A strong and pervasive information campaign by the Members Countries to quantify the economic benefits induced by the user will be crucial to support policies.

Decentralized energy plants could support these involving scenario too. The adoption of local supply programs are more suitable, sustainable and manageable than more articulate nationwide projects and they can lead to energy independence through self-production and self-consumption. At this aim public authorities should issue policies which could contribute to create a Zero Kilometer energy too. The cooperation production needed in biogas plant could be a significant environmental and social opportunity to develop decentralized energy plant.

A way to advantage the decentralized biogas plants diffusion could be the incentives schemes and the authoritative processes. If incentives have an economic importance, a certain timing of projects approval can encourage the investment and find shortcut for the authoritative process so to support biogas projects. This is absolutely important when these are based on social and economic cooperation. The diffusion of urban biogas, in the end, go through the reduction of waste and energy costs, achievable by district efficiency plant projects; urban biogas micro-generation plants just need to be encouraged by clear, safe, stable and innovative regulatory framework in addition to shared guidelines now being finalized.

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Abstract. Nowadays, urban regeneration is a crucial problem. Vegetation is always an option but, usually, a lack of scientific knowledge prevents to using it. We will try to evaluate the influence of vegetation (mainly trees) in some “well living” parts. We shall use Barcelona (Mediterranean climate) as reference. Results could then be extrapolated to other climates (our interest is in Dominican Republic). Based in a previous study for summer 2013, we have prepared a more extended plan in order to systematize the precise influence of each species in the comfort of people in Barcelona. We have also identified, in Ochoa’s model, parameters to be measured for its right use in Barcelona. From 20 of June to 20 of July 2015, a wider campaign of measures has been undertaken. With these data, a “summer calibration” of the model has to be done. A campaign of measures in winter (end of January 2016) will be used for a “winter calibration”. Once it will be done, we will be able to predict numerically the influence of some types of trees in the comfort of the people. Implementing our results in common use software will be the final phase in this work.

1. INTRODUCTION

The vegetation has been through the years an element of great use to people. It has been used as protection, building material, subsistence element, among others. So the value that currently characterizes human life. Due to the growing climate change has generated an increase in studies to decrease this phenomenon, vegetation being one that brings great changes, especially in the urban heat island.

The vegetation characteristic metabolism contribute though his many factors that make changes in the immediate and surrounding environment. This metabolism include evapotranspiration (transpiration and evaporation), photosynthesis, oxygen, among others. These processes performed by a natural life cycle, achieved countless contributions to the welfare of the user. In this article we will study how radiation affects a town and as vegetation through their protection creates a shadow helping to reduce energy inputs making the welfare of the user in urban areas. The structure of the article will be the research objectives, methodology and results.

In section 2, ¨Research goal¨ the general objectives of the work are explained and presented the case study in which deepens, explaining the evaluation method used combining software with physical measures. In section 3 the case study described, the radiation received is simulated and the measurements obtained are presented. Section 4 provides a comparison of the results. The differences between the various options species and orientation are discussed.

2. RESEARCH GOAL

Objectives.
The aim of this study is to evaluate qualitatively and quantitatively vegetation use for decreasing thermal inputs in order to obtain the welfare of the user. The effect of shadow in urban canyon configuration will be the main parameter.

State of art.
Many studies have been done about indoor thermal comfort environment. Some of which we can mention are Gagge et al, Fanger et. al.and Mayer and Hoppe. On the other hand have been studies about outdoor comfort environment, we can mention are Swaid et. al, Nikolopoulou et al , Givoni, Spagnolo and de Dear and Godoy Muñoz.

Research related to outer space, we can mention are Melo Barbirato et al, Ochoa, Echave, Cantón and Fernández , Rosas Lusset , Tumini, Rojas Cortorreal and López Ordóñez

We are currently conducting research on how the vegetation modifies the environment by creating more welfare immediate. Therefore for this research twelve (12) species have been chosen or urban use in which measurements are carried out in two seasons of summer and winter year, to evaluate how each tree species can contribute to the environment or elements of value and secondly calibrate a model of user comfort. Five (5) blocks and four (4) places where tree species are located were selected. The work presented in this paper, two (2) species and two (2) street will be exposed.

The methodology used will be quantitative and qualitative. The indicators of research are the characteristics of the canyon of street, user comfort and vegetation. The urban variables are urban canyon (height of the building, street width and sky view factor), user comfort (personal, physical and derivatives) and vegetation (type tree species, morphology and density of foliage)

3. STUDY CASE

The case study is The Eixample, located in Barcelona, Spain. With a latitude of 41º 23´ (Figure 1). In this article we will discuss only one of the points analyzed in this way to explain more specifically the methodology and the results. For the selecting the areas to be analyzed the variables density space usage by the user, the type and condition of the tree species were taken into account. The Eixample district was the area chosen for analysis. In this paper we will discuss the measurements made in the streets Carrer Casanova and Carrer Londres (Figure 1). Both streets have the same proportion but slight differences in the height construction, the same type of vegetation which are Celtis australis (Almez) and Platanus x Hispánica (Platáno de sombra). The first method is to perform field analysis, study of vegetation, simulation of radiation in Heliodon program and in situ measurements.

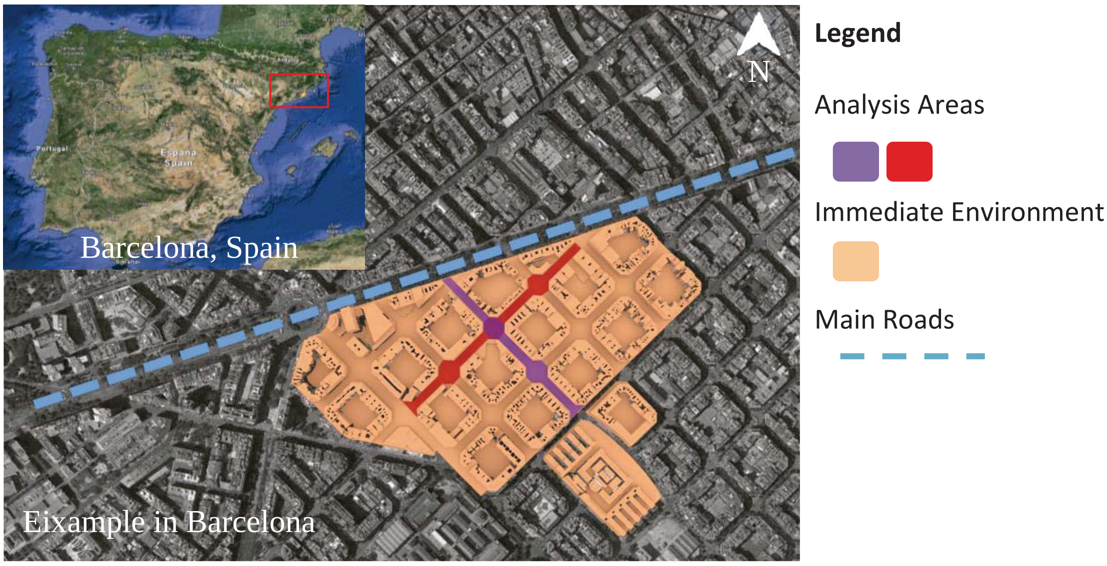

Fig 1. Study case. Barcelona, España.

3.1. Urban canyon Description.
The indicator are width (W), height (H), sky view factor[1] (SVF) and vegetation.

3.1.1. Street Casanova

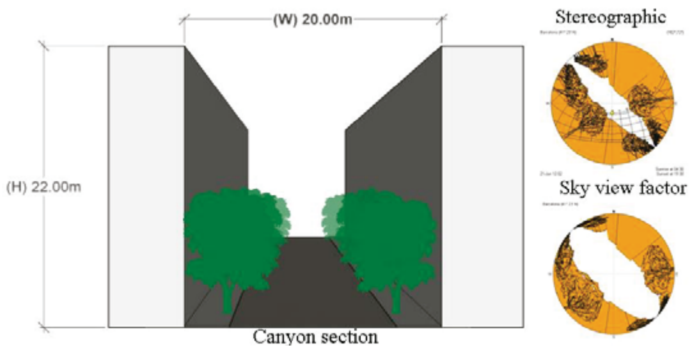

Fig 2. Canyon Section. Street Casanova.

This street have the orientation SE-NO. The urban canyon proportions are 20 meters of width (W) and 22 meters of height (H). It has a varied height from 9 to 30 meters. Average for this analysis being 22 meters high (H) was performed. From the center of the urban canyon it has an aspect of H/W=1.1 and the SVF of 37.4% (figure2).

Tree Species
The vegetation in the urban canyon are *Celtis australis* and *Platanus x hispanica* (figure 3 and 4). They are distribute with a distance of 3 meters between each. For the evaluation of the trees have determined the following indicators on the type of tree, morphology and density of leaves. The indicators are height, diameter, density and type of shade leaves.

For the evaluation of the shadow is determined a coefficient of 1 to 0. Where 1 is dark shadow is the densest form (not allow the passage of ants of the incident radiation). The coefficient of 0.50 is the average shade (which allows the middle step of the incident radiation) and 0.1 is the soft shadow (the shadow that allows the full flow of incident radiation).

[1] Sky view factor: The extent of sky observed from a point as a proportion of the total possible sky hemisphere [20]

Tree Species Celtis autralis (Almez)

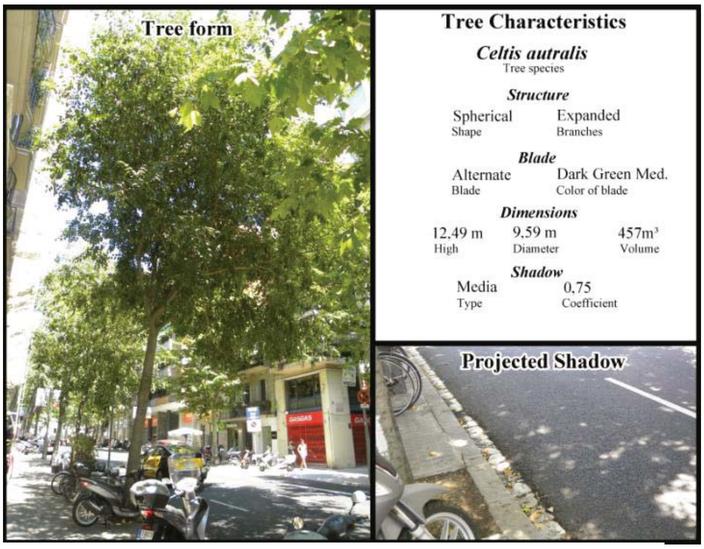

Fig 3. Celtis australis (Almez) Street Casanova.

We can see in the Figure 3 the morphological characteristics of this tree. We can see that has a density leaves of 457 cubic meters. The shape, height and volume can project a dense medium shade.

Looking at the image of the shadow we can see that the passage of incident radiation is very little and that these stains of light is not perceived completely defined. Achieving surfaces are protected.

Tree Species *Platanus x hipanica* (Plátano de sombra)

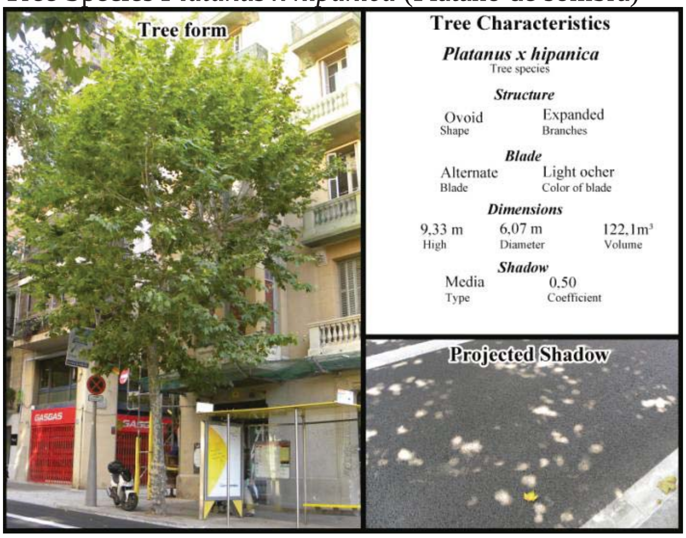

Fig 4. Platanus x hispanica (Plátano de sombra). Street Casanova.

In the image 4 we can see the morphological characteristics of the tree. The shape, height and volume can project a medium shade.

In the image project shadow we can see how the shadow change in comparison with the figure 3.

In this case the leaf density is 122 cubic meter. It can be seen as the stains are more defined allowing increased passage of incident radiation.

3.1.2. Street Londres

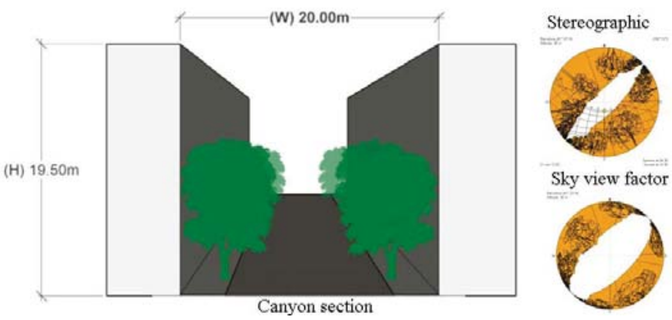

Fig 5. Canyon Section. Street Londres.

This street have the orientation NE-SO. The urban canyon proportions are 20 meters of width (W) and 19.50 meters of height (H). It has a varied height from 3 to 30 meters. Average for this analysis being 19.50 meters high (H) was performed. From the center of the urban canyon it has an aspect of H/W=0.97 and the SVF of 39.5% (figure 5).

Tree Species

The vegetation in the urban canyon are *Celtis australis* and *Platanus x hispanica* (figure 6 and 7). They are distribute with a distance of 3 meters between each. For the evaluation of the trees have determined the following indicators on the type of tree, morphology and density of leaves. The indicators are height, diameter, density and type of shade leaves.

Tree Species Celtis autralis (Almez)

Fig 6. Celtis australis (Almez) Street Londres.

In the image 6 are the morphological characteristics of this tree. We can see that has a density leaves of 10 cubic meters. The shape, height and volume can project a dense medium shade.

Because of the orientation of the street, the shadow is projected into the facade of the building.
In this image you can see how the incident radiation spots are irregular.

Tree Species *Platanus x hipanica* (Plátano de sombra)

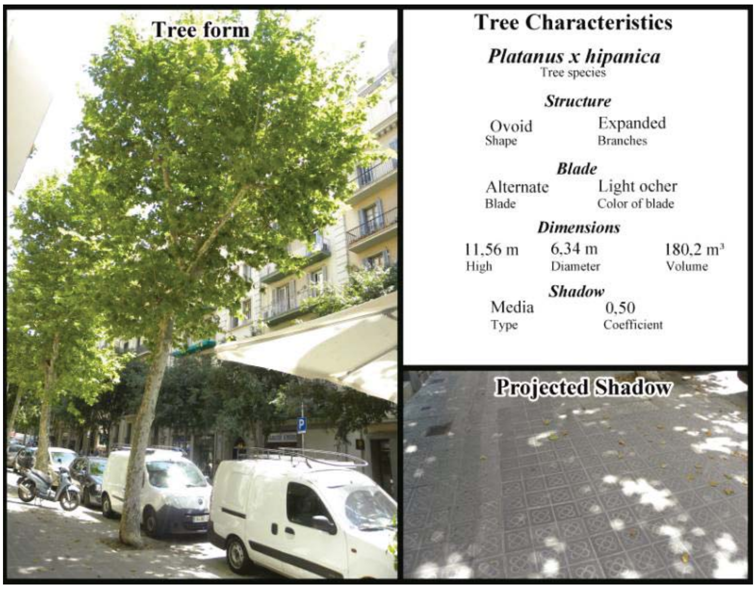

Fig 7. Platanus x hispanica (Plátano de sombra). Street Londres.

In the image 7 in this case the leaf density is 180 cubic meter. It can be seen as the stains are more defined allowing increased passage of incident radiation.

Unlike Figure 6, the incident radiation spots are defined. By the orientation of the street shade protects pavement surfaces.

3.2. Simulations

Simulations were performed on the program Heliodon. These simulations were performed to evaluate the performance of the streets on a summer day (25 June and 16 July, 2015). In this way we can know that radiation impinges on this street sections.

3.2.1. Day 25 June, 2015 and day 16 July, 2015

Fig 8. Simulation radiation incident. Heliodon program.

Fig 9. Simulation radiation incident. Heliodon program.

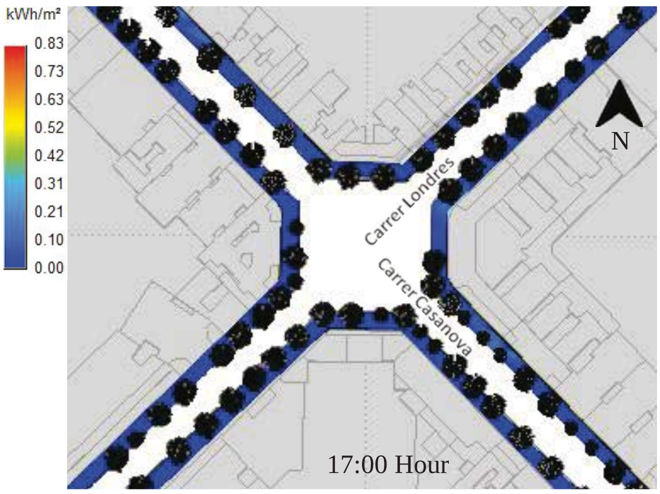

Fig 10. Simulation radiation incident. Heliodon program.

At 9:00 hr we can observe the behavior of the radiation incident on these streets. We can see that most perceive radiation incident surfaces oriented NE, E and SE.

The incident radiation is estimated from 0.52 to 0.72 kW/m^2. But the shadows of the trees does not allow passage reducing the incidence between 0.0 to 0.31 kW/m^2.

At 13:00 hr the incident estimated 0.83 kW/m^2, the projected shadow vegetation reduce the incidence reaches between 0.0 to 0.42 kW/m^2.

At 17:00 hr can be observed in figure 9, the incident radition is very short ranges being no more than 0.21 kW/m^2.

We can see how in the course of the day, the areas affected by radiation but does vegetation through its projected shadow protect these surfaces, greatly reducing this incidence.

We can see how in the course of the day, the areas affected by radiation but does vegetation through its projected shadow protect these surfaces, greatly reducing this incidence.

We can conclude that the worst time of day is the 13:00 hours. Since this time the value for the main findings.

The goal of these simulations is to obtain qualitatively points which are more favorable for in situ measurements. So quantitative analysis is pending, this was achieved through in situ measurements.

In situ *measurements*

The analysis methodology for in situ measurements were comfort parameters (in and out of the shadow of the tree) and photographic survey of the species. These measurements were performed in two seasons at the same points of measurements. The first measurement was the June 25, 2015 (time in which there was a heat wave) and the July 16, 2015.

3.2.2. Day 25 June, 2015

Weather conditions recorded air temperature (Ta) were 25 ° C to 27 ° C. Relative Humidity 37 to 58%. And the wind remained in the range of 2 m / s. After that we Radiation Incident data and surface temperature in the following charts.

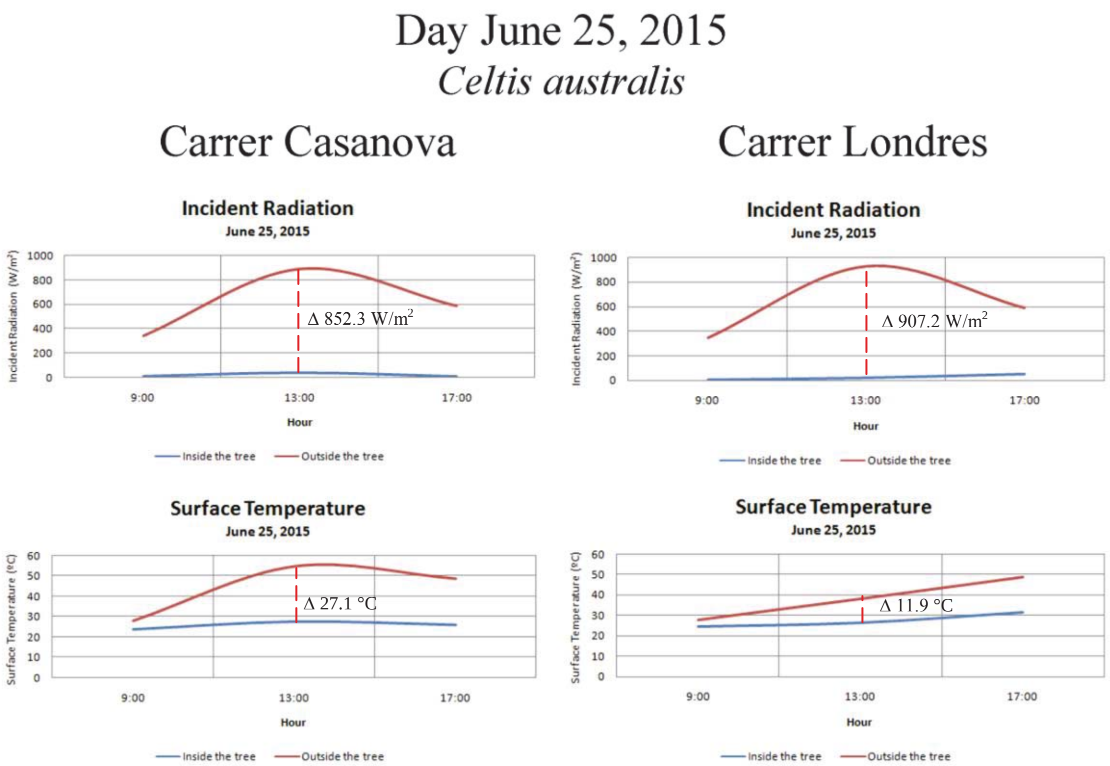

Fig 11. In situ measurements.

We can see (Figure 11) both streets, the behavior of the tree species *Celtis australis* on the parameters of air temperature (Ta) and relative humidity (RH) are similar, do not record any change. But the level of incident radiation (R) is greater in Carrer London (NE-SW) at 13: 00h, this is because of its orientation. In the graphs of the surface temperature (Ts) being different Carrer Casanova (SE-NO) at higher temperatures. It is because it receives more radiation incident along the Carrer day London. We can see in this chart as the tree species it decreases both the incident radiation to 907.2 W / m^2 less and the surface temperature of 27.1 ° C to less in both orientations of the street.

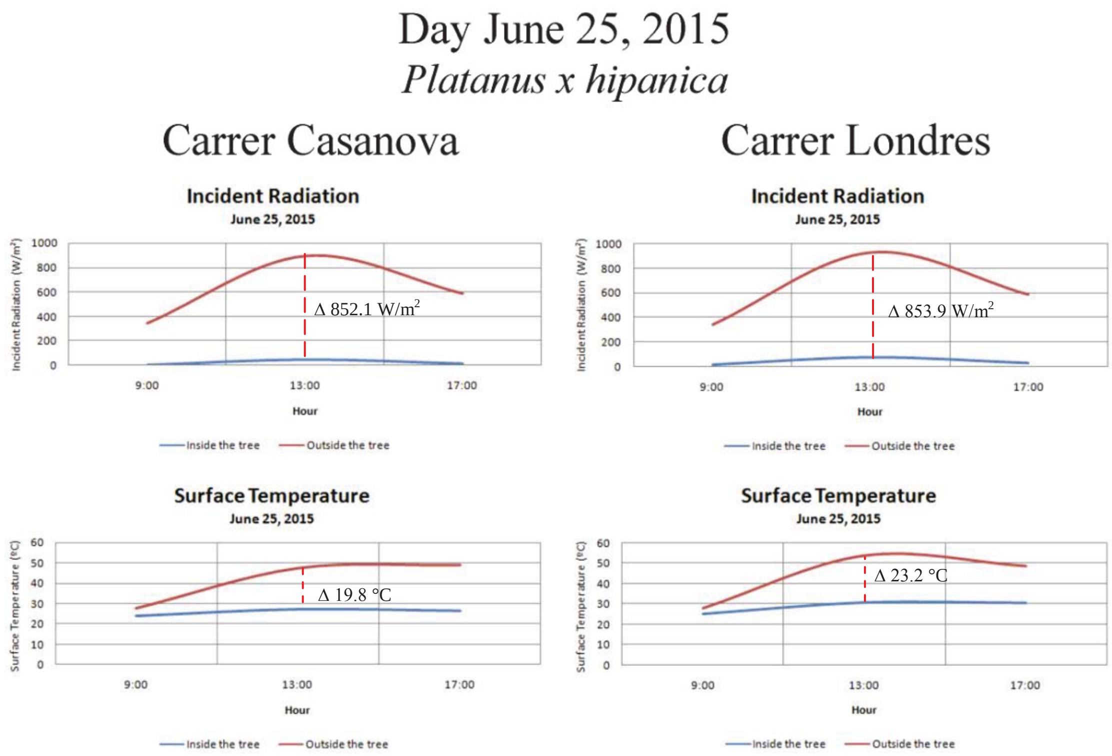

Fig 12. In situ measurements.

The *Platanus x hispanica* (figure 12) achieved a decrease in R incident to 853.9 W / m^2 achieving Ts reflected in the decrease to 23.22 ° C. Apart from this we can see that the highest incidence street is Carrer Casanova, however the worst time (13: 00h) the highest incidence is reflected in Carrer London due to its orientation.

3.2.3. Day 16 July, 2015

The same measurements were then performed in the month of July 2015. To evaluate changes that might already exist in the indicators evaluated due to the heat wave that occurred in the month of June.

Weather conditions recorded air temperature (Ta) were 27.5 ° C to 31.4 ° C. Relative Humidity 42 to 55%. And the wind held in a range of 2 m/s. After that we Radiation Incident data and surface temperature in the following charts.

The *Celtis australis* can see (figure 13) BP and HR are consists of two streets. Biggest difference occurred in Carrer Casanova up 828.8 W / m^2. Reflecting a difference in surface temperature of 21.7 ° C Carrer Casanova.

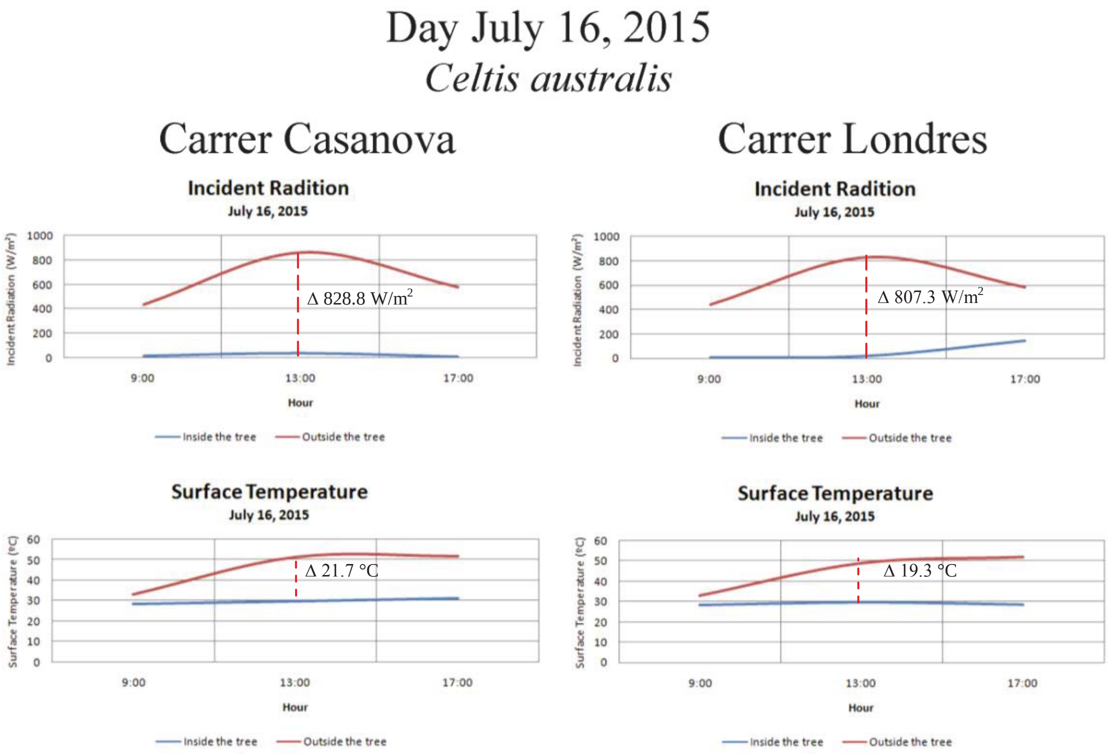

Fig 13. In situ measurements.

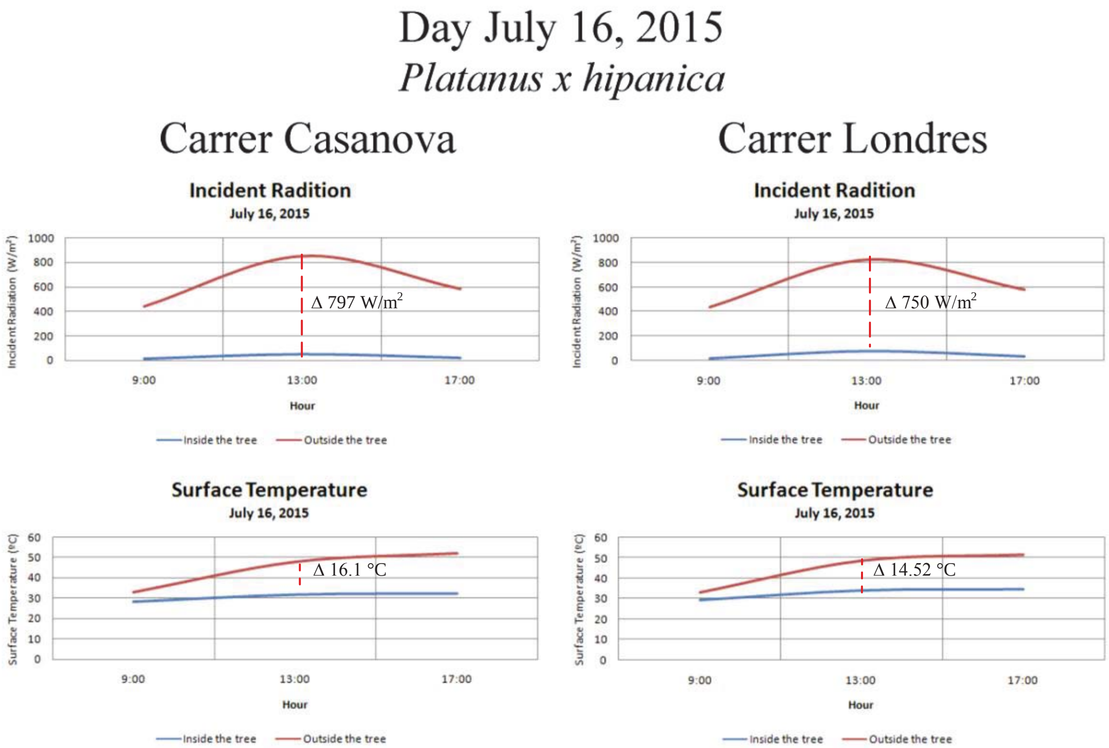

Fig 14. In situ measurements.

The *Platanus x hispanica* (figure 14) shows that the Ta and RH are consists of two streets. Registering biggest difference in Carrer Casanova 797 W/m^2. Reflecting a difference in surface temperature of 16.1 ° C Carrer London.

3.2.4. Results

Tree species.
Among the species we can see that the *Celtis australis* shows greater protection because the range of interior / exterior difference is greater. Recording ranges up to 907.2 W/m^2 (Carrer London) of incident radiation and 27.1 ° C (Carrer Casanova) surface temperature difference.

Analyzing in depth the street that receives the highest incidence in this case Carrer Casanova can see that both species carry out their protective function both in simulations and in situ measurements. Comparing these results shows that the *Celtis australis* (medium dense shade) provides better protection. In the worst time achieved a difference of 852.3 W/m^2 and 27.1 ° C. The *Platanus x hispanica* (partial shade) 852.1 W / m^2 and 19.8 ° C were recorded apart.

Comparison of the two measurements days
The simulations and measurements made in the month of June and July born with the objective to evaluate qualitatively and quantitatively the variation that might exist in a typical day between the two months due to the two heat waves were recorded in the month of June. The results obtained can they appreciate the air temperature ranges on both days two months remained at a similar range in the town. But a decrease in relative humidity in the June, July unlike this may be due to condensation by the temperature rise and the same tree species absorb humidity as a coping for the wave was recorded hot. In the incident radiation and temperature of the soil surface if you can see an increase in relation to July. As these two indicators which allow us to appreciate the event partly lived.

Orientation and relationship forms.
The observed results is that Carrer Casanova (SE-NW) receives more contact with sunlight during the day Carrer London (NE-SW) due to its orientation and each has SVF. Although the SVF is higher in Carrer London (SVF 39.5%) compared to Carrer Casanova (37.4% SVF) orientation influences the incidence is higher. As both variables together that determine how it will be affected the urban canyon.
It is invited to conduct studies of these three points studied, but with in situ measurements continuously, to assess these variables in more detail. For greater extent how these variables can be modified environmental and surface elements.

4. CONCLUSIONS AND METHODOLOGY FOR SANTO DOMINGO, DOMINICAN REPUBLIC.

4.1. Overall conclusions

The vegetation is an excellent element to achieve protection to urban areas and according to the characteristics of the same this incidence may be higher or lower. This study comes a proposal for analysis and urban improvement for Santo Domingo, Dominican Republic. Tree species were *Celtis australis* analysis and *Platanus x Hispanica*, both proved to be an element of protection for the solar incidence.

In our study we used the Carrer Casanova and Barcelona Carrer London urban canyon whose characteristics are an aspect ratio H/W for Carrer Casanova = 1.1 and H/W for Carrer London = 0.97. A SVF C. Casanova 37.4% and SVF of C. London = 39.5%. Our work can show the quantitative difference due to the orientation. The next target will be the analysis of two types of urban canyons where you can appreciate biggest difference SVF ranges and H / W.
First we simulated to assess quantitatively the most sensitive points. Measurements have confirmed the correct selection of points by results.

4.1.1. Methodological proposal for Santo Domingo, Dominican Republic.

A. As methodological approach we propose the main points to make:
B. Assessment of the type of vegetation should make a survey of selected tree species in urban canyons. To thereby determine their species and characteristics. Following the chips developed in this work.
C. Analysis of urban canyons must perform studies of the main streets urban canyons or behaving as an urban canyon.
D. Take measurements: You must perform simulations and measurements in situ to assess the climatic behavior of urban canyons. Measurements with continuous measurement devices (probes, stand alone ...) allowing adjustment for quantitative predictions of the simulation program.
E. Proposed solution or improvement: After all the above points assessed. Assess where you must make changes or improvements, make the design proposals.

5. ACKNOWLEDGMENTS

The Ministry of Education of the Dominican Republic (MESCYT), To Dra. Helena Coch and her group of teachers AEM 2012 – 2013 and COST Action TU1104 Smart Energy Regions.

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Sustainable Use of Heritage Resources

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Abstract.: Built heritage is a sensitive resource, prone to natural erosion and affected by human intervention. Sustainable use of heritage resources in the Maltese islands is underpinned by objectives set out in the 'National Strategy for Cultural Heritage' and the 'Strategic Plan for Environment and Development'. Strategies are effective if the objectives are implemented and monitored. The aim of this study was to determine how Local Councils are responding to the strategic objectives of 'National Strategy for the Cultural Heritage'. This paper presents results of the first stage of a mixed-methods research, which consisted of cross-sectional questionnaires comprising of open, closed and 5-point Likert scales developed from existing policies and distributed amongst all Mayors within Malta and Gozo. Whilst almost three-fourths of respondents (71%) have not developed a sustainable policy framework, 68% showed willingness to develop it. Less than half of local councils (45%) had identified cultural heritage reserves, with only 39% developing conservation plans; however 73% were prepared to develop such plans in their localities.

Keywords: Sustainable, Heritage, Resources, Policies, Local Councils

1. INTRODUCTION

Regeneration of historic places and buildings emerges amongst key factors in the shaping of the urban fabric of the Maltese Islands. The Ministry for Tourism, Culture and Environment identifies 22 strategic objectives aimed at improving quality and standards within the culture heritage sector. New targets are introduced to be implemented within a five year timeframe, by 2017. The improvement of the townscape and environment in historic cores and their settings emerges as one of the urban objectives in the Strategic Plan for Environment and Development (Malta Environment and Planning Authority, 2015). In addition, the inclusion of historical urban areas of cities and historic cores of other numerous towns and villages as part of the Valletta 2018 European Capital of Culture concept is amongst the objectives of the Draft National Tourism Policy 2015-2020.

Though the Antiquities (Protection) Act was established in 1925 to provide a legal framework for conservation of historic buildings, the need for a coordinated approach towards protection of historic buildings and land use planning was established more than six decades later by the Building Permits Act of 1988, and subsequently with the approval of the Environment Protection Act and the Development Planning Act. Furthermore the Culture Heritage Act, Cap. 445established a role of Superintendent of Cultural Heritage.

The national agency responsible for land use planning and environmental regulation in the Maltese Islands is the Malta Environment and Planning Authority which was established under the Environment Protection Act and the Development Planning Act. In 2004 Malta joined the EU with the responsibility of implementing the EU Acquis. Legal instruments were thus developed quite recently, almost within the past quarter of a century, and since then policies and guidelines have provided a framework for the regeneration of historic buildings.

To date there is paucity of published studies exploring the examination of policies in the regeneration of historic buildings in the Maltese context.Urban conservation, cultural heritage and tourism have been explored extensively internationally; whilst contemporary use of historic buildings for the tourism industry has been researched in several countries. By contrast, the study of contemporary use of historic buildings in Malta has not attracted similar attention. The aim of this paper was to provide a contribution to redress this imbalance.

1.1. Aim of the study

The overall aim of the survey study was to obtain information of how the strategic objectives set out by national authorities are affecting the localities in Malta and Gozo.

1.2. Ethical approval

The study was approved by the Research Ethics Committee of University of Bolton.

2. METHOD

2.1. Inclusion criteria

Mayors from each of the 68 Local Councils within Malta and Gozo were included.

2.2. Questionnaire development

The questionnaire was designed to obtain general and broad information on the Local council awareness and participation in policy formulation. Mayors were asked to comment on the state of historic buildings in their localities and what they are prepared to do, and to indicate the funds and resources available. The questionnaire provided information on the objectives of policies set out by different national authorities.

Apart from obtaining information about existing policies, the questionnaire focused on the emerging policies of the Strategic Plan for the Environment & Development. Moreover the questionnaire was based on the policies and objectives as set out in the National Strategy for the Cultural Heritage, National Commission Persons Disability and Malta Tourism Authority.

The local councils of Malta and Gozo were grouped into six districts. The sixty eight localities were grouped for aggregation purposes in accordance with the Local Administrative Unit (LAU) classification.

A pilot study was carried out with the mayors of six localities, covering the six different districts within Malta and Gozo. In view of the small number of localities in Malta, the same six mayors participating in the pilot study were requested to provide feedback on the layout and content of the questionnaire to ensure face and content validity, without compromising the sample size for the full study.

A number of measures were taken to enhance response rates in this study, namely: high quality, short, focused questionnaires with appropriate formatting; an ‘invitation to participate’ letter;university logos on letters and questionnaires; reassurance of confidentiality throughout; and three reminders. The possibility of collecting the questionnaire by hand was also offered to participants.

The principal researcher also liaised with the executive secretary of the Association of Local Council’s (AKL) and informed him about the study and offered the possibility of attended the annual plenary meeting of Mayors to present a summary of the findings. A meeting was also held with the Parliamentary Secretary responsible for the local Government who liaised with the Director Local Government regarding the study. The objectives of the questionnaire were explained within the context of this research and the possibility of presenting findings in conferences or other fora was also discussed.

2.3. Sampling and sample size

All mayors were contacted by email to the executive secretary of each Local Council. In view of the small number of local councils in Malta, all mayors were included in this study .Following an initial invitation to participate letter sent to the official email address of each of the local councils of Malta and Gozo, the questionnaire was sent to all mayors at the end of November giving participants a two week deadline, which was extended to four weeks following two reminder emails. The Director Local Government also sent an email to all Mayors encouraging them to participate in the study if they have not already done so.

2.4. Data handling and analysis

Data were inputted into SPSS® V21, with an independent reliability check undertaken on all entries, screening data for errors by analysing frequencies and checking for outliers. Descriptive statistics (frequency, percentage) were analysed for the categorical data, i.e. demographics and Like rt scale responses and nominal data, i.e. Yes/No.

3. RESULTS

The response rate following the first mailing was 13% (9 responses), which increased to 65% (44 responses) following two reminders, telephone call and letter from Director Local Government. Table 1 presents a description of the responses in relation to respondents' district.

Table 1: Number of responses in relation to respondents' district

District	Number of Localities	Percentage response (Frequency) % (n)
Southern Harbour	14	50 (7)
Northern Harbour	13	46 (6)
South Eastern	11	82 (9)
Western	10	60 (6)
Northern	6	83 (5)
Gozo and Comino	14	79 (11)
Total	68	65 (44)

3.1. Sustainable policy framework and conservation plans

Figure 1 depicts whether local councils have developed a sustainable policy framework, as well as management and conservation plans for properties of national importance and their willingness to do so.

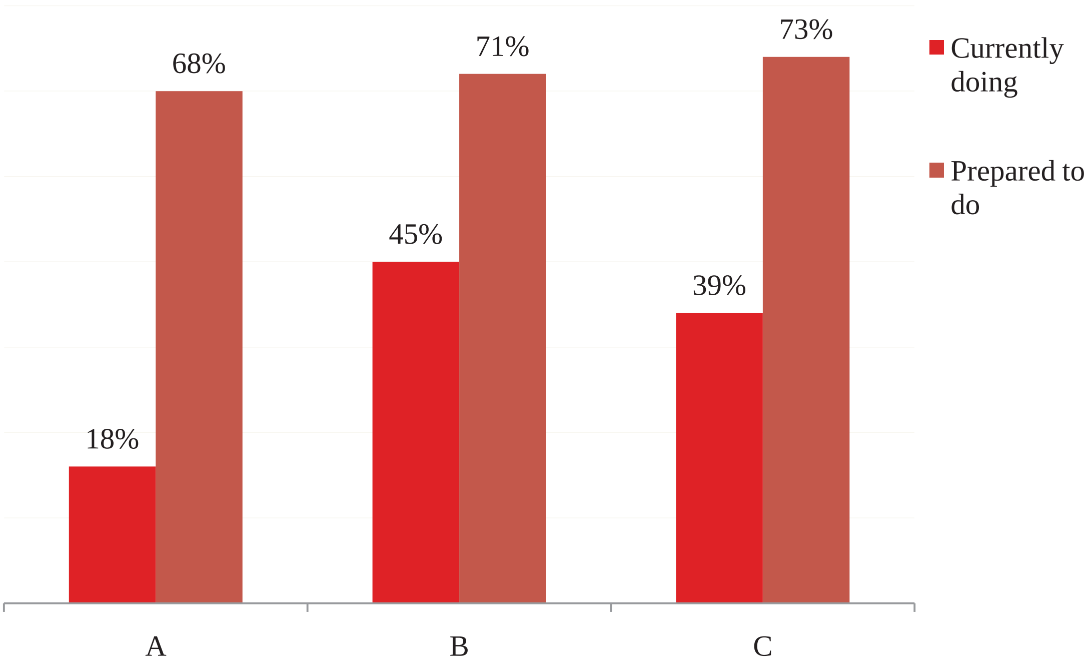

Fig 1: Development of sustainable policy framework and conservation plans A) Develop a sustainable framework, B) Identify cultural heritage reserves of heritage resources, C) Develop conservation plans

3.2. National funding and resources

Figure 2 describes the percentage of mayors who claimed that the local council had obtained national funding in the past three years to undertake heritage related projects, and the local council has the sufficient resources and technical resources to undertake heritage related projects within the local council boundary.

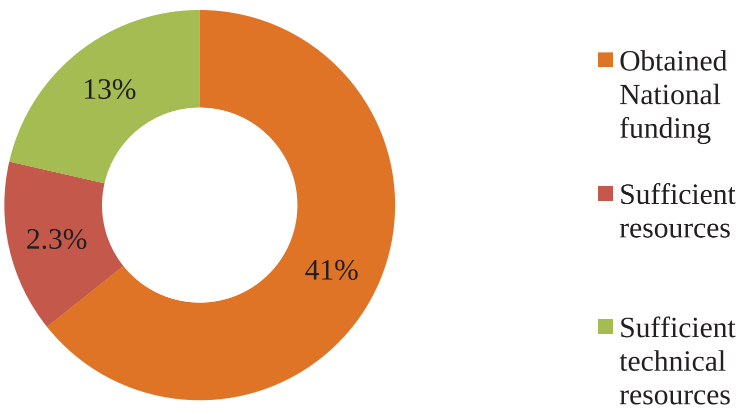

Figure 2: National funding and resources within the local council

3.3. Tasks and measures for improving governance

Figure 3 depicts tasks and measures for improving governance in the locality's built heritage sector.

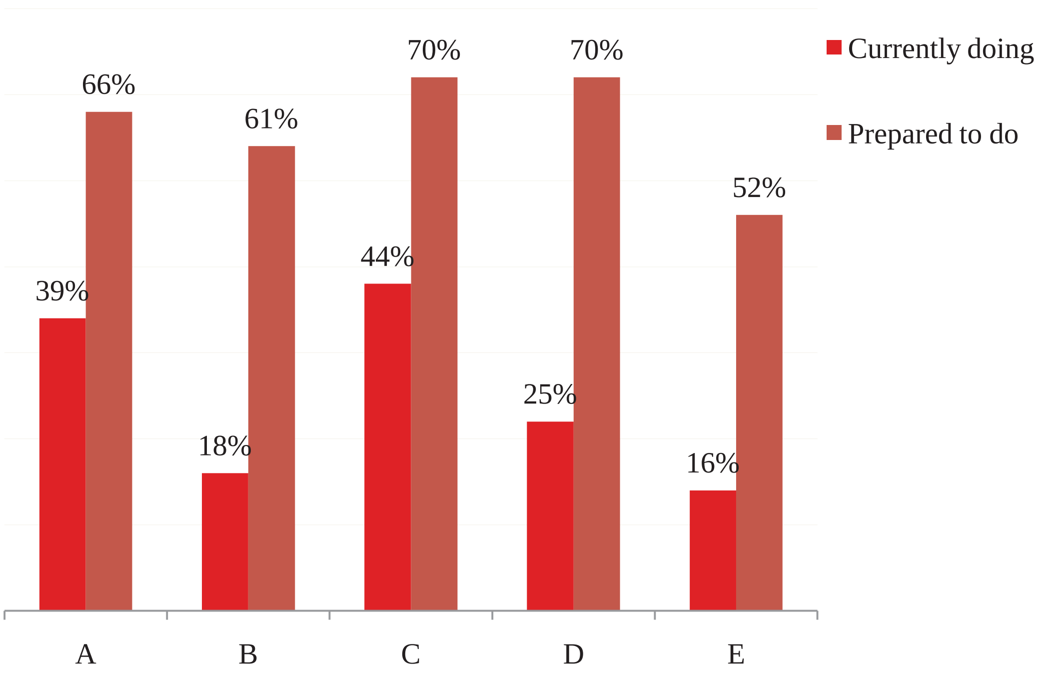

Figure 3: Tasks and measures for improving governance in the locality's built heritage sector A) Identifying innovation roadmap, B) Review legislation and policies, C) Develop local heritage inventories, D) Organize heritage seminars, E) Identify paraments for data collection participation

3.4. Information about proposed policies and objectives

The majority of respondents (88%) claim that their local council requires more information about proposed policies and objectives.

4. DISCUSSION

The aim of the survey study was to obtain information of how the strategic objectives set out by national authorities are affecting the localities in Malta and Gozo.Sustainable growth emerges as one of the three priorities of the Europe 2020 strategy. Maltese Government has identified the rehabilitation and conservation of historic buildings as one of the sectors targeted for investment in order to improve citizens' quality of life, and has directed priorities in the European Union(EU) funding towards attaining this objective. Yet the results clearly indicate that local councils lack information about these proposed objectives.

Heritage is of paramount importance to the national identity as it does not merely generate revenue from visitors but it also provides wider economic and social benefits at large. Hobson argues that interest in conservation of historic buildings which was of interest only by an elitist minority has been shifting to a grass-root majority. Contributions from multi-disciplinary backgrounds are joining those of architectural and archeological experts interpreting cultural and societal aspects with the architectural and historical aspects.

Cultural heritage is an asset for the Maltese Islands with major contributions towards the tourism and leisure industry. Malta Tourism Policy 2012-2016 identifies the potential of heritage sites and historic buildings across the Maltese Islands which are non-utilised mainly due to the inaccessibility of the sites or else because they are left in state of abandonment. The Malta Tourism Authority highlights that in 2012, 42% of all tourists chose history and culture as their main reason to visit Malta. Resource sustainability and reuse of historic buildings features also amongst the general principles of the National Spatial Framework under the EU 2020 strategy. Yet, whilst it is a priority for the Government of Malta to preserve Malta's cultural heritage and promote such heritage as a main contributor of the tourism product, only 2.3% of mayors claim that their local council has sufficient resources.

Strategic Plan for the Environment & Development (SPED) calls for efficient use of land and sea, urging Government to adopt a sequential approach by prioritizing development primarily through re-use of existing developed and historic buildings, followed by re-development of already developed land and lastly to use vacant land. This objective is also coupled with improvement of livability of Malta's historic towns and villages and to redirect the population back into the urban cores. Results of the questionnaire indicate that local councils are willing to undertake tasks and measures for improving governance in their locality's built heritage sector. The implementation of these set of measures will make Malta move closer towards the ambition of Europe in line with its strategies for 2020, and to shift towards sustainability, smart and inclusive growth.

5. CONCLUSION

Strategies to increase awareness and improve current involvement of local councils in policy development are imperative. This study clear shows that local councils are willing to actively participate in policy development

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Sustainable Strategies for Promoting the Horezu Pottery and the Cultural Landscape of Horezu, Romania

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Abstract. Romania occupies on the UNESCO list of Immaterial Cultural Patrimony only four positions. Since December 2012 the Horezu pottery entered this short list. This pottery is present in most of the handicraft stores all over the country, but otherwise lacks any other promotion policies: information, data about the geographical position and the beautiful hilly landscape, history of the handicraft and data about the former and contemporary artists, presentation of the variety of decoration motifs, local gastronomy traditions etc. Today tourists having come to visit the 17th century Monastery, shortly stop to see the pottery in display on the access road and eventually acquire some products. The visibility of the valuable production of Horezu is minor, but a greater influx of tourist in the present conditions would be unsustainable. The paper intends to outline some directions for a sustainable promotion of the pottery itself, but also of the varied valuable traditions, of the architectural dowry, of the natural attractions and of other riches existing in the area.

1. INTRODUCTION

Horezu pottery is a traditional craft, still kept in northern Valcea county, at the foot of the Carpathian mountains. The craft was included in the UNESCO Immaterial Heritage List as it reflects the local identity and knowledge of potters from Horezu, kept from generation to generation, thus preserving techniques and specific motifs that give it a unique character.

However, the craft is in danger due to the reduced opportunities in the rural areas of supporting this occupation financially, thereby reducing the number of craftsmen. Like all rural areas in Romania, Horezu faces the migration of the population towards towns and cities.

A survey* was undertaken by this research team in order to study the national recognition of UNESCO's Immaterial Heritage status, as well as other important aspects concerning the Horezu Microregion. Results responses show that less than 30% of Romanians know that the pottery craft was included in the list of Immaterial Heritage and, about the importance of the craft, 18.3% of respondents said they did not know more details. Also other features of the Horezu Microregion are not aknowledged among the local community and nationwide. Just 17,6% of respondents said they had visited the area given that fact that 2 UNESCO objectives out of the 10 ranked in Romania are located here. Therefore, the entire cultural heritage should be aknowledged in order to create sustainable strategies for the development of the area and to sustain the invaluable pottery craft.

*The study was conducted for academic purposes. The questionnaire was submitted to a number of 135 subjects with proportional allocation of respondents by age and gender, with a theoretical margin of error of +/- 5%.

1.1. *The pottery craft in Horezu Microregion – maintaining a valuable tradition.*

Authentic artisans in the area still use traditional materials and techniques. In the village of Olari (which means “potters”), where most of the craftsmen are located, visitors are invited to find out and experience the process that lies behind creating pottery, and also the origins and the characteristics of the decoration.

Currently, there are around 50 local potters, meeting within the Potters Association of Horezu which helps maintain a authentic core by promoting quality ceramics. According to the survey conducted in this study, among those who own a piece of Horezu pottery, 63.8% said that they purchased it from craft stores, 12,5% from local craftsmen and 23,7% by ordering on the internet. Just a little percentage of visitors or buyers had a direct contact with the local craftsmen, which clearly shows that the object is more recognised than the actual handicraft that has to be preserved, undermining its cultural importance.

Given the higher media coverage, the ceramics trade flourished in the last years, but the consequences are not necessarily encouraging. The lack of sufficient information for the buyers, instead of protecting the UNESCO status, allowed the development of opportunistic initiatives under the title of Horezu pottery, producing and promoting low quality objects. As a result, more and more objects appeared on the market, addressed to unsuspecting buyers representing pottery produced in other locations, even in other countries.

The packages in which the ceramics are sold provide little or no information on what is actually important about the craft, do not provide suitable images or present the history of the handicraft, where the actual craftsmen are and how they produce the objects. Along the acces road, pottery is sold in improvised shops that do not present a suitable image of the craft. These aspects have a negative impact on the number of potters still practicing in Horezu, as their work is not fully appreciated and the authentic products are less promoted, being replaced by cheaper, mass produced objects.

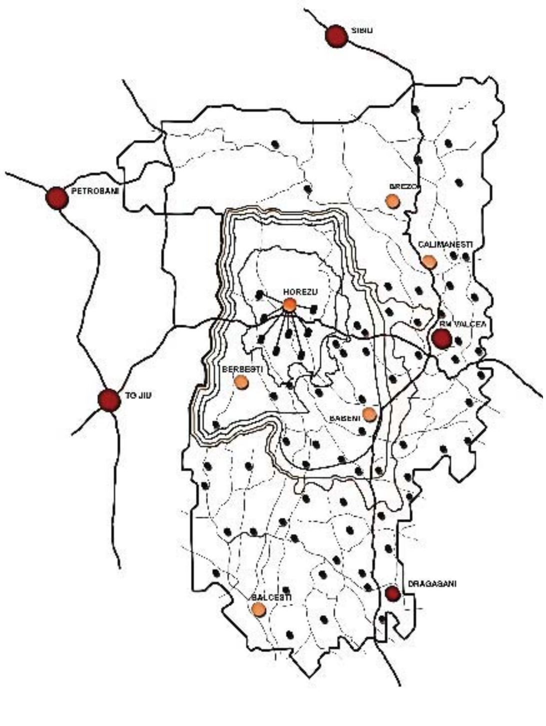

Fig 1. Map showing the location of Horezu Region and its area of influence

Fig 2,3. How the pottery is presented and sold in local shops

2. THE EVOLUTION, TECHNIQUES AND SPECIFIC MOTIFS OF THE HANDICRAFT

The Romanian pottery has a long history having its roots in the prehistoric time and later developed by the Thracian Dacian with influences from the ceramics of the Greeks and Romans. The Horezu pottery fits into the overall Romanian ceramic but has a very specific style.

In the eighteenth century the Horezu pottery adapts from a more practical endeavour towards art and luxury, having its highlight in the reign of Constantin Brâncoveanu, founder of the Horezu Monastery, ruler of the Southern Principate of Wallachia between 1688 -1714. After establishing the School of Art at the Horezu Monastery, the Brâncoveanu art style flourished by developping its vocabulary from the elements of the local tradition with influences of the Ottoman Empire branch. The Brâncoveanu Art Style shows an original Romanian character enriched with foreign influences. It is visible in architecture, local traditions and crafts that are perfectly adapted to the natural environment. Therefore, the pottery craft continues to be a correspondence between the values embodied by the built heritage – The Monastery of Horezu, and those of the Immaterial Heritage. This is noticeable by the coherence that is found both at the conceptual level of the entire object - be it artistic or actual construction work, but also at the level of compositional processes and motifs.

The techniques of creating the Horezu pottery remained the unchanged untill now. A specific sequence of operations and instruments are similar to all craftsmen: a mixer for cleaning the earth, a potter’s wheel and comb for shaping, a hollowed-out bull’s horn stick for decoration, and a wood burning stove for firing. The paints used are natural and the colors vary from bright shades of brown, red, green, blue to the so called "Horezu ivory" for the background of the vessels.

The Horezu’s pottery decoration combines traditional motifs with later oriental influences resulting in unique ornamental compositions. The decorative friezes are made through the alternative use of a variety of motifs. Abstract geometrical ornaments are used – points and spirals, freely drawn or in combined patterns using the local process of “jiravare” (decoration technique made by leaking the colors on the edges of the vessels towards the center, usign a pointed instrument called “gaita”). Cosmomorphic ornaments like the sun and the star are two images that organized the radial layout of the ceramics - spirals, twists and circles being representations of the solar symbol. Floral motifs : rosebuds, wheat ears, zoomorphic elements: birds, snakes, as well as antropomorhic elements or scenes, are inspired form the rural settings.

Many of the symbols do not maitain a connection with the initial source of traditional inspiration, but they are kept from generation to generation. The best known motif, “Cocoşul de Horezu” (the Horezu Rooster), detached its meaning from the original symbol of rebirth, but remained in the collective consciousness as the emblem of a traditional and authentic lifestyle.

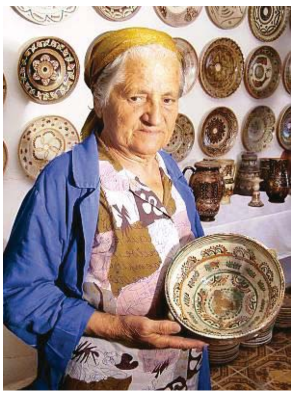

Fig 4. Traditional potter

Fig 5,6. Traditional plates with the Horezu Rooster and Eufrosina Vicşoreanu star the decorations are made using the procces of “jiravare”

3. LOCAL INITIATIVES AND SUSTAINABLE PROPOSALS FOR PROMOTING THE HOREZU CULTURAL LANDSCAPE

The Horezu Microregion is a territory with a population of about 33,200 inhabitants. The studied area is part of a homogeneous geographical unit, known as "Oltenia de sub Munte" (Oltenia under the mountain). An microsystem can be identified, grouping a set of villages with strong historical, economical and socio-cultural connections in which interventions can be optimized for an efficient exploitation of the natural resources in the area.

The attempt to update the Horezu rural setting, far from representing a nostalgic attitude, can be considered as a sustainable solution in terms of urbanism and conservation of the cultural landscape in the economic and social disruption following the 1990 change of political regime. By detecting the essence of the traditional traits, one can rephrase the rural social life and offer the option of shaping specific identities that match the requirements of local, regional conflicting tendencies thus expressing and highlighting important cultural elements.

The cultural landscape is a set of traits, characteristics and forms of an area which provides a specific interpretation of the following elements: physical forms, natural and anthropic systems, built environment.Only through raising awareness and promoting these elements, supported by appropriate local economic development policies, the area can be regenerated and better living conditions can be provided for the residents.

Fig 7. Buila Vânturarița

Fig 8. Potter in his workshop

Fig 9.The Horezu Monastery

3.1. Promoting the Horezu Pottery

In order to sustainably promote the Horezu pottery, several measures are required that aim to protect the authentic image and the craft itself. First, it is important to conceive a coherent brand that will provide sufficient information to costumers on the character of the craft and its importance. This can take place through information campaigns or through craft fairs where traditional artisans can exhibit their work and share their craftsmanship.

The first attempt to create a local brand initiated in 2015, at the "Cocoșul de Horezu" Ceramics Fair by introducing the title "Horezu - where the earth takes shape".This event was attended by the General Assembly of the European Territorial Cooperation of Ceramic Cities, politicians and local artisans. This meeting was conducted in order to connect Romanian potters with their counterparts in other European countries in order to find together workable solutions to ensure the permanence of this craft, affected by the loss of important centers of the competition with cheaper industrial products.

To get the desired results, information campaigns need to be interdisciplinary, addressing varied audiences through interactive activities which may include workshops and lectures on ceramics and the Microregion of Horezu while offering full touristic packages that include all the local attractions.

Pottery workshops are constantly organised in the local information center mainly addressed to tourists, as well as in the “Constantin Brâncoveanu” Highschool and the “Children’s Club”, having as target group more than 2500 youngsters from the Horezu region.

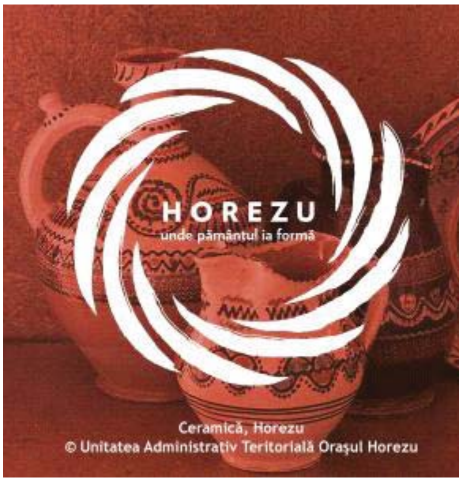

Fig 10. Logo of the campaign

Fig 11. Decorating the plates using traditional "Horezu - where the earth takes shape" techniques and materials

3.2. Local community

Local initiatives were started with the allocation of european funding for implementing social development projects in the mountainous and hilly areas of Romania. As an example the - "Horezu Region Fair – pleasure of living" was feld from June the 29th to July the 1st 2012, funded by Human Resources Development Operational Programme 2007-2013," Invest in people ".

Also, in 2012, the project “Look at Horezu” was implemented. By this project the local administration collaborated with other associations like the CIMEC - Institute for Cultural Memory, Arhitext Design Foundation, Atlantic Association – France , as well as the local community represented by TinEcoArt Association and Kogayon Association that provided cultural information and training programmes, initiating and carrying out artistic activities.

This project aimed to stimulate the recognition of the existing heritage as a contribution to the local development for younger generations. Through interaction in the project team and through art education activities, the residents of the Horezu region discovered local values and resources that they formally passed over indifferently and learned to appreciate and protect them. Following this project, meetings and exhibitions were conducted and a brochure was published that summarised all the existing Horezu heritage sites, allowing a more cohesive approach for the promotion of the specific elements of the area.



Fig 12, 13, 14. Activities undertaken by the Kogayon Association in the Buila Vânturarița Natural Park with teenagers from the Horezu region

3.3. Ecotourism

In 2005, the city of Horezu became a tourist resort of local importance, and in 2008 the European Commission, through the EDEN project, assigned to the Horezu region the title of "European Destination of Excellence", inducing a new stage for the development of the town according to its touristic status.

Eventhough the number of tourists in the area has increased in the last years, the economical benefits are still scarce as the variety of attractions isn't sufficiently promoted, while the quality of the services is unsatisfying.

The current activities exploit spontaneously and intuitively the advantages of position, environment and natural resources of the area, yet lacking the necessary efficiency to adapt to contemporary conditions. The local economic development is currently dependent on the vitality of the new privat sector, as part of the tendencies towards an economy based on offering services. Through ecotourism the spectrum of traditional economic activities can be ensured instead of being marginalized or replaced. Recent initiatives are encouraged by granting European funding for bioproducts, by establishing small factories that produce local goods or by providing accommodation in traditional households. Thus, the local economy is not subordinated to external influences.

Touristic activities conducted under the title of ecotourism offer specific opportunities to appreciate the valuable natural and cultural objectives. The local population and the tourism industry is forced to use natural resources in a sustainable manner. Only a coherent discourse is able to support ecotourism in the area through the provision of infrastructure, service development, and the organization of thematic routes that can include both the natural environment – the Buila Vânturarița Natural Park, the local customs and traditions – the Horezu ceramics, and the built environment – the Horezu Monastery. These measures can ensure a wider range of tourists and a longer visit, opening a more satisfying touristical market.

4. CONCLUSIONS

The Horezu Pottery and the Horezu Monastery Horezu are emblematic elements that represent the region, ensuring a specific identity. The perpetuation of the pottery craft also suggests the residents initiative of maintaining a cultural core often suppressed during the communist regime.

Including the 2 objectives in the UNESCO heritage list expresses the international recognition and the need to undertake measures to maintain these values during the contemporary difficult transition period. For creating a coherent and sustainable strategy, the entire region has to become more attractive, thus solving the existing social problems.

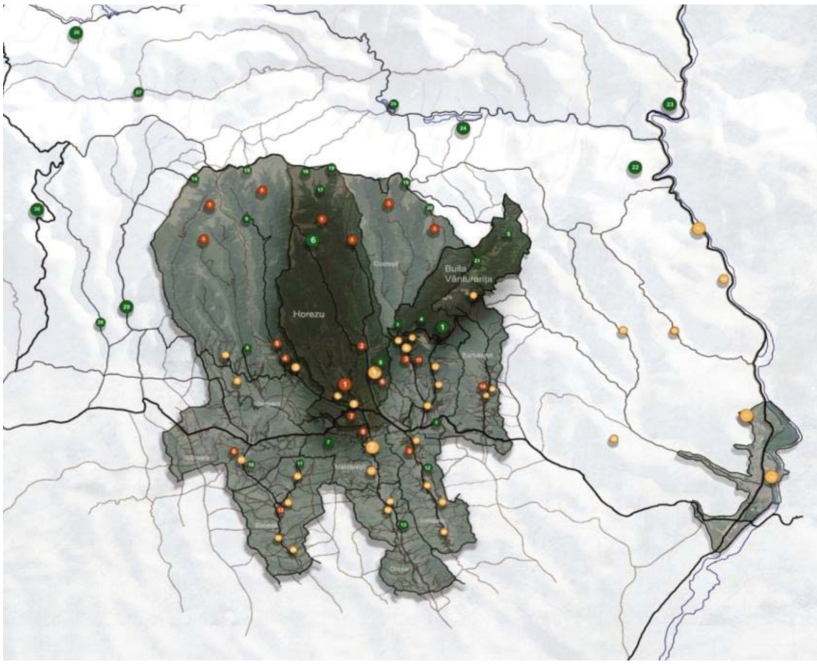

Fig 15. Map showing more than 35 objectives concerning the cultural landscape of Horezu

By pointing out these two special components of the cultural landscape, the region's population can identify with a specific character, which is actually a first step in establishing an administrative cooperation and more community involvement. All these initial endeavours are primarily intended to educate and train the residents, as to easily adapt to the administrative changes implemented nationwide.

Ecotourism may constitute in this sense a variant of gaining independent economic support for the region. Aknowledging all the varied qualities of the Horezu region, one can broaden the touristic range of offers and have the ability to disseminate information among more potential visitors. One of the main target groups are children, they are offered the chance to experience a complete educational program by organizing pottery workshops, hiking and site seeing, while adults have the possibility to be connected to a traditional way of life.

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Kenzo's Master Plan After the Earthquake - a Base for Regenerative Development of Skopje

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Abstract: Human impacts on the world's landscapes are dominated by the ecological footprints of urban areas that now stretch across much of the globe. The World today, seeks to identify concepts and policies that help cities to harness their own regenerative capacity in order to reconcile the their ecological footprints with their geographical magnitude. The planning and management of new cities as well as the retrofitting of existing ones needs to undergo a profound paradigm shift. The urban metabolism must be transformed from its current operation as an inefficient and wasteful linear system into a resource-efficient and circular system. Skopje, the capital of the Republic of Macedonia, bears a different past than other cities and particularly in relation to architectural and urban utopias. On a summer morning in 1963, it was reduced to rubble by a catastrophic earthquake. The UN stepped in and organized an international urban planning competition. The Japanese architect KenzoTange, who was one of the key members of the Japanese "Metabolists" won. The main conception of the plan was based upon a contrast between the inner city and the rest of the city centre, with a strong framing by large residential buildings which form

1. INTRODUCTION

Sustainable development has become the global orthodoxy in today's society. It seems straightforward that living today as if there is no tomorrow is irresponsible. But in fact, this is what we are doing.Regenerative and sustainable are essentially the same thing except for one key point: in a sustainable system, lost ecological systems are not returned to existence. In a regenerative system, those lost systems can ultimately begin "regenerating" back into existence. Put more simply, regenerative systems create a "better" world than we (humans) found it, now and into the future.

Today, urban design now needs to consider the functionality of towns and cities. Our urban spaces rely on more than just what buildings are used for. As the populations of our cities have expanded the demand for a higher standard of living has meant that planners and designers now have to take into consideration transport structures, community development, environmental and sustainable methods of building, and the needs of individuals. Urbanization however can cause problems. Inadequate housing, pollution, and insufficient transport systems are just a few.

A new urban agenda is necessary in ensuring that cities not only become resource-efficient and low carbon-emitting, but go beyond that to positively enhance the ecosystems which provide them with goods and services. The solution lies in thinking beyond the vague and rather unambitious notion of sustainability and, instead, actively working towards regenerating soils, forests and watercourses. The aim is to improve rather than merely sustain their currently degraded condition. Urban economies that recognize the value of nature's services and the costs of their loss set the stage for a regenerative city. This requires investments in companies, organizations and funds that generate measurable social and environmental impact alongside financial return. A new compass is needed to guide bold policy directions, change incentive structures, reduce or phase out harmful subsidies and engage business leaders in a vision for an innovative, new economy.

At the core of the regenerative vision is ensuring that future generations inherit a robust and intact world in which individuals can realize their full human potential and that cities continue to provide opportunities for all people to improve their quality of life. Even as cities increasingly rely on goods and resources from all around the world, knowledge and prioritization of ensuring the long-term availability and vitality of these supplies is lacking.

This new agenda transforms urban areas into regenerative cities that dramatically reduce their dependency on fossil fuels, boost the deployment of renewable energies, reintroduce water to the hydrology cycle and make sewage reprocessing and nutrient capture a central plank of urban waste management. Globally there are numerous examples for good policies and practices for regenerative urban development. There are no examples of a fully regenerative city, but many cities and urban regions around the world demonstrate that regenerative urban development is reality in certain sectors and areas. The shared characteristic of these examples is the desire for a new narrative on what the urban landscape can and should look like.

The Urban Regeneration approach gained an advanced direction for change-based urban transformation to provide integrated guidelines and policies for urban development and change. The Resolution on Millennium Development Goals in 2000 (UN, 2011) and the Agenda and Global Action Plan in 2003 (UN-HABITAT, 2011) produced programs for conservation and rehabilitation of historic and cultural heritage as well as for socioeconomically sustainable development strategies and participation models in the decision-making process. MDGs and Habitat Agenda converge on integrated sustainable development in urban transformation. The Mapping Document of Creative Industries Task Force-CITF in 1998 in the UK (Couch, Fraser & Percy, 2003) promoted integrated creative strategies to develop cultural industries by creative programs and to support creative entrepreneurship in an urban process (Jarvis, Lambie& Berkeley, 2009). The Safeguarding of the Intangible Cultural Heritage in 2003 provided a global cultural strategy for protecting cultural diversity and providing sustainability in creative processes (UNESCO, 2011). The creative tourism strategies of the Creative Cities Network in 2008 initiated an integrated heritage strategy for promoting local heritage and enriching cultural identity through sustainable projects (UNESCO, 2011). Finally, the Leipzig Charter and the Toledo Declaration put emphasis on integrated sustainable development and integrated urban regeneration in order to support mixed policies and strategies to create intelligent, sustainable and smart green development as well as to produce social renewal and eco-economy (EU, 2011). Finally, the Europe 2020 Strategy in 2010 formulates a new economic strategy based on a digital agenda and competitiveness for achieving smart, sustainable and inclusive growth by institutional networks and stakeholder models (EU, 2011). Heritage-led, competitiveness-led, creativity-led, knowledge-led urban regeneration are being used as methods by agent based partnership models. This method of integrated urban regeneration could also be identified as post-liberal rent-oriented urban regeneration.

Changes in urban redevelopment regime that aim to manipulate the market economy as a key player in urban regeneration has been providing the emergence of specific frameworks, guidelines and policies in the planning agenda. Therefore, rent/client-oriented spatial planning and self-autonomous hedonic changes in land-use have emerged during this period. As a result of the rise of creative society in cities, innovations and entrepreneurial principles have emerged within a political and economic ideology.

2. URBAN PLAN IN SKOPJE AFTER 1963S

The Skopje region is one of the most seismically active region in Balkans, characterized by up to IX MCS (MercalliCancamSeiberg) earthquakes (Mihailov and Talaganov 1985). The 1963 Skopje earthquake remains one of the most devastating European earthquakes in the 20th century and one which attracted almost unprecedented levels of international co-operation and assistance. A severe earthquake hit the city, killing more than 2,000 people and destroying roughly 65 percent of the buildings in the city. After the earthquake in 1963 the city has witnessed one of the largest rebuilding efforts on European ground. The United Nations sent the most comprehensive mission in city planning while more than 60 countries contributed with various help. Skopje was proclaimed the city of solidarity by the international community.

The United Nations set up a special fund for preparing a master plan for the city. The Greek architectural firm Doxiades Associates and Polish architect Adolf Ciborowski drew up a regional plan for Skopje in 1964, but they left its center city - an approximately two-square kilometer area - open, with the intention of undertaking a more detailed study through an international competition. In January 1965, Kenzo Tange was invited by United Nations to participate in an international planning competition for the reconstruction of Skopje. Tange considered this project significant not only for its international influence, but also because it would make “a model case of urban reconstruction,” so he accepted the invitation. The competition involved eight design firms, four of them from Yugoslavia and one each from Holland, Italy, Japan and the United States. The Jury awarded the first prize to Tange and the second prize to Yugoslavian architects Radovan Mischevic and FedorWenzler, but proposed that the two winning firms work together to develop a final plan. The architects were Kenzo Tange (Japan), Van den Broek and Bakema (Holland), Luigi Piccinato (Italy), Maurice Rotival (USA), AleksandarDordevik (Yugoslavia) , Eduard Ravnikar (Yugoslavia), Radovan Mischevic and FedorWenzler(Yugoslavia) and SlavkoBrezorski(Yugoslavia). The other architects from Tange's office included Sadao Watanabe and Yoshio Taniguchi.

Fig1.Model for reconstruction of Skopje

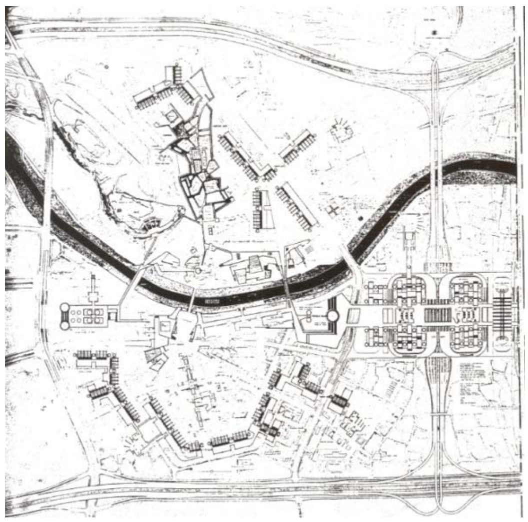

Fig 2.Tange’s Plane for reconstruction

Tange's proposal was based on two metaphorical concepts, the “City Gate” and “City Wall.” They referred to the two major elements of the city with distinct characters. The proximity of residential areas to the business district was expected to bring vitality back to the city. The plan for Skopje demonstrated the remarkable continuity of Tange's approach to city design. The concept of City Gate was based on a linear axis concentrating all urban functions related to communication and business operation. In the middle of this stretch was gigantic gateway structure resembling incoming traffic from regional highways. The axis ended at Republic Square, Skopje's principal civic space on the River Vardar and surrounded by state and municipal facilities. (Figure1 and Figure 2)

The City Gate literally a gate into the city, would be put in the area where a new train station and gateway structure for highway entries to the city would be build similar to the composite transportation centre in Le Corbusier’s Ville Contemporaine, the City Gate was characterized by the convergence of all traffic systems - rail, car, bus and pedestrian movement - and served as the point of transition between regional traffic and local traffic. The railway terminal was designed as an underground structure. Occupying different levels above it were automobile parking decks, transit terminals, and pedestrian zones. The transportation centre was joined by a central business district known as City Gate Centre, to form the city main axis. Along the axis were clusters of buildings include a number of office towers, a library, banks, exhibition halls, cinemas, hotels, shops and restaurants - all connected to the railway and bus terminals with elevated motorways.(United Nations Development Programme, 1970: 297-301).

What distinguished the Skopje projects from Tange's earlier schemes, however, lay in the symbolic meaning of the urban structures, which the architect had started to explore in his Tokyo Bay project but had not fully developed until the Skopje project. The entire city was bound together with the symbolic concepts of its “gate” and “wall,” serving both as programmatic features and metaphors for the urban form. In fact, these metaphors constituted the springboard for the whole design.

Transitions in Tange's attitudes toward historical context and locality can be detected between his two monumental plans: the 1960 Plan for Tokyo and the 1965 Plan for Skopje. The Tokyo project was dominated by a strong forward-looking aspiration. Tange criticized the city’s existing organization as a “closed structure” which belonged to a “medieval town,” obsolete and dysfunctional for a city of Tokyo’s magnitude. In Skopje, the architect turned to the construction of a “City Gate” and a “City Wall,” seeking to recover the meaning of a traditional town. The urban scene in Skopje after the violent earthquake could not be less chaotic than the urban scene in Tokyo in 1960. However, instead of rebuilding the city, Tange tried to preserve the remaining structures in Skopje and used the City Wall to frame the historic areas. He also treated the city’s geographical characteristics in a delicate manner. The competition jury highly marked and appreciated Tange's scheme for its successful “incorporation of Kale Hill into the composition of the center” and the “integration of the left and right banks of the Vardar [River] by their development with public buildings, shops, bridges, and pedestrian squares and platforms.” Tange's transition to a more sophisticated approach to history and local conditions could be justified by the fact that the Skopje plan was proposed for actual implementation, rather than being a theoretical project like the Tokyo Bay Plan. It was also certain, however, that by turning to historical metaphor and localism, Tange demonstrated his awareness of the cultural implication of urban structures and attempted to expand his language of urban design through employment of metaphorical and symbolic elements. In Tange's vision, Skopje remained a planned city under an architect's complete control. He later recalled that, when working on the Skopje project, he had to make a decision between two approaches to formulating the building guidelines. The first approach would “lean strongly in the direction of allowing the city to grow and alter in a dynamic and recurrent pattern;” the planner's responsibility would mainly involve “establishing space usage and wall lines that guarantee open spaces and flow,” leaving other things for free construction and urban growth. With the second approach, “an ultimate form for the whole is designed on a virtually constitutional basis and all development is made to agree with this form;” this method would “make it possible to produce a total image. Tange chose the second approach because he felt that the Skopje project was less about stimulating the growth and redevelopment of a living city than it was about establishing a total image around which a devastated city could be resurrected. (Themes: Myths of Modernism –Content Case Study , 2011).

It is worth to be said that Political factors in Skopje also influenced Tange's decision. The architect later wrote: “Yugoslavia is a Socialist country in which land is not privately held, the city government had sufficient power to make it possible to introduce our total plan.” He believed public land ownership was on his side in realizing his grand plan. In Japan, dispersed private land ownership made it difficult to carry out large-scale urban redevelopments within existing political parameters. Tange's and the Metabolists urban projects thus remained theoretical speculations. Tange found Skopje a promising land to realize the idea of a total plan that he had put toward theoretical proposals for Tokyo.(Zhongjie Lin:KenzoTange and the Metabo List Movement, Urban Utopias of Modern Japan, New York, 2010).

2.1. The Post earthquake development of the Tange’s plan

In the period between 1963 and 1980 Skopje has became the most internationally built city in former Yugoslavia. Architects from all over Europe participated in international architecture competitions and built many public buildings. Today Skopje can be seen as an open-air architectural museum. The rebuilding of Skopje was largely completed by 1980(Figure 3). The

Master Plan was a creature of its time. Architect-planners of the modern movement, confident in their role of remaking the post-war world, worked with the state rather than with the people. Public participation was limited to the public being allowed to view the scale model of the new city when the planners had finished it. The main elements of the Master Plan were partially realized on the ground, creating a new city that is today spacious and generally well-organized.

Fig 3. Up to date signs of realized Tange's Master plan

The plan included a series of architectural competitions for cultural, public and commercial buildings located in the central area of the city, such as: Macedonian National Opera and Ballet Theatre, Central Skopje Post office, State Hydro-meteorological Institute, the "city wall", City Shopping Center, GoceDelčev Student complex , City Archive, University building, Transportation Center, Macedonian National Radio and Television building, News Publishing Agency "Nova Makedonija", National Bank of Macedonia, Nikola Karev High School, Macedonian Academy of Sciences and Arts, Saint Kliment Cathedral and etc. Throughout realization of those buildings and the positive impact Kenzo Tange had on the community of Skopje, in the wake of a devastating natural event, it's clear that will not soon be forgotten although that time is evenly with brutalist architecture – a style typified by geometric themes and raw concrete .(Figure 4)

Fig 4.State Hydro-meteorological Institute,Student complex,Academy of science, University building,Macedonian National Opera and Ballet Theatre

3. DEVELOPING SUSTAINABLE CITY WITH A COMPACT NEIGHBOURHOOD IN A TANGE'SMASTER PLAN

The main reason for partial realization of the Tange's Master Plan were economic crisis in the beginning of 1980's in former Yugoslavia and non economic investments at that time. It must be emphasized that the weak economy has caused the inability of full realization of the master plan. Many free land have remain in central area with the old houses built from 1929-1948. The target of analysis of this paper is old forgotten neighbourhood and its possible transformation in a new neighbourhood adequate to the location in existing plan respecting as much as possible sustainable principals of urban planning in the urban block.

There are two definitions of the neighbourhood. It is a region or community within one city and as well it is an area that surrounds a particular place, person or thing. The proposed neighbourhood has been analysed in three major viewpoints. From the point of social sustainability the density of population is essential for a richer social life. In addition, creating a pedestrian city with open spaces as important element of the neighbourhood has always been a challenge for planners. Creating jobs in the environment of residential neighbourhood and employment of local population in the same urban area with efficient public transport to the remote areas is a precondition for economic sustainability as a second point. For the environmental sustainability the most important elements for the neighbourhood is downing the intake of all types of resources, reduction of waste generation, use of local resources for reduction of pollution (use of renewables), increasing green areas and urban agriculture.

3.1. *Proposed Urban design for the location*

To allow pedestrian movement through the location and the space to be found at the mental map of the citizens, through its central part is foreseen to have a path that cuts location and passes through three squares with different activities. The new urban development plan envisages to build three high-rise towers on the north side of the site in order its shadow to throw on the river Vardar. The first tower is scheduled to be business, middle tower is a business hotel and conference facilities, and the third is a residential tower. South of the main walkway has another office tower attached to the lower building that represents the boundary between the first two squares. The other buildings on site are with a height of no more than 8 floors.(Figure 5). It is also planned that all buildings have interactive ground floor with shops for better animation of passers-by who do not work or live in those facilities.

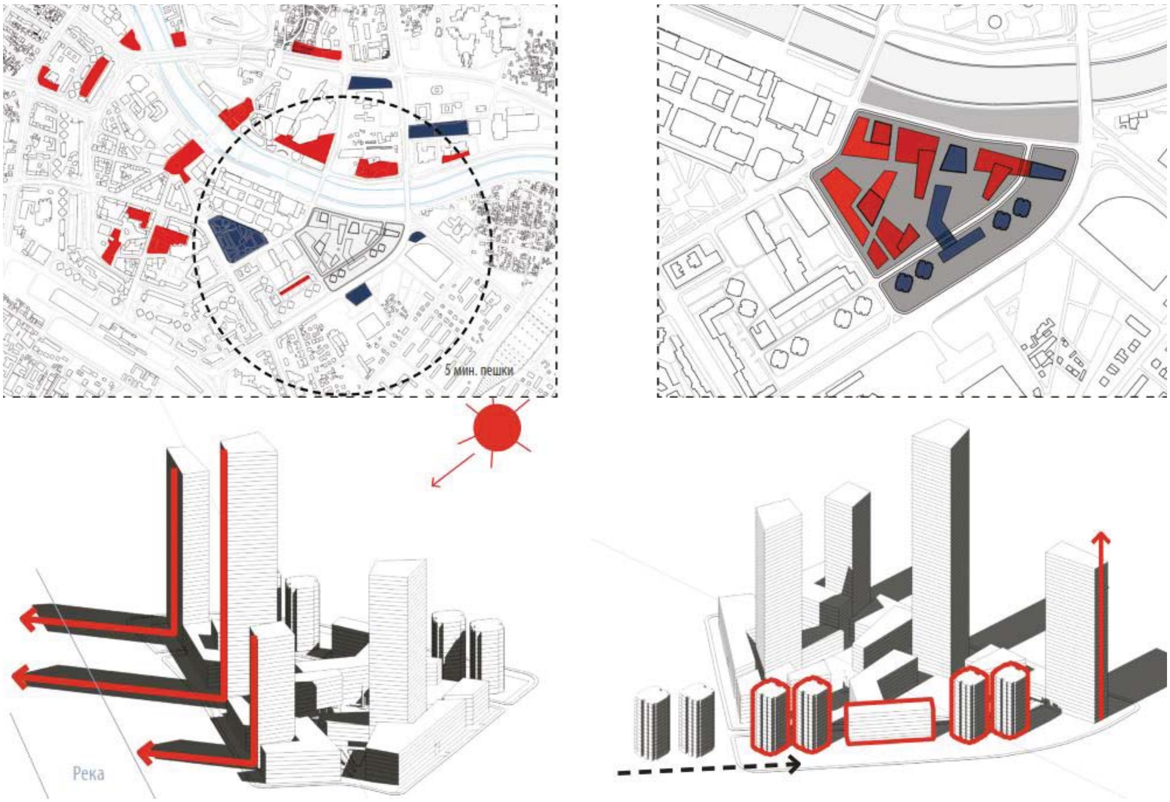

Fig 5. Position of the location, Urban plan and 3Dmodel for the insulation of buildings

The main space for socialization on the location are the three newly squares. The creation of three squares form articulate open space that would have temporary uses such as events, holiday bazaar, pop-up market by day, concerts, performances outdoor. Thus this area would be of interest for the residents in the housing of the location and the citizens of Skopje, which is very important for utilization of central spaces in the city and creating a compact city. The entry plaza, commercial and family square are three squares with different purposes.(Figure 6)


Fig 6. 3D visualization of the three squares

With a newly proposed plan a half of the site is open space. Currently this location have tremendously low density of 19 people per hectare, while the new urban plan is envisaged to have 296 inhabitants per hectare. If take into account the people who work here and will be staying at the hotel then the maximum population density would be 1221 inhabitants per hectare. The total area of the site is 89.932 m^2 of which 6.908m^2 belong to the river Vardar. The remaining space in the new plan is divided into four areas: 13.357 m^2 park, 27.325 m^2 open spaces (squares), 20,460 m^2 area under buildings and 21,882 m^2 traffic areas (streets).With this allocation, 45.3% of the site is green and open public space. For the residents in residential buildings at the site is provided 3 underground parking levels below residential towers.

4. CONCLUSIONS

The futuristic Tange’s Master plan had in his basis a lot of todays sustainability city planning fundamental elements such as economic, social and environmental aspects of town land use and development. Unfortunately the ideas of Japanese “Metabolists” group to which KenzoTange belongs, didn’t achieved full realization of their Master plan for town of Skopje. Even, after 50 years of the earthquake there are still places for possible interventions.

Architecture and society has always been in unbreakable relationship and mutually dependent. Architectural Science as follows (or should follow) the needs of societies, changing, improving and proportionally evolve with society. World population is constantly growing. Cities are the largest and most complex human settlements. They are the least sustainable form of settlement, however there are more and more cities every day and they are becoming larger and larger. Therefore, the city needs to redefine and accommodate the needs of the present and the future. Only a sustainable city can remain attractive for its citizens. Sustainability as an aspect of contemporary urbanism does not have a long history. Although after the industrialization cities started to change in sustainability as “ekopolis”. Sustainable urbanism aims to change people’s habits in the city and to make better use of the space within the city. Fewer cars, alternative means of transport, efficient public transport and easy access to more amenities within walking distance are some of the most important changes of this proposal. Building higher buildings on expensive land in the city means financially more efficient architecture and larger open public spaces with temporary uses, as temporary structures are the most sustainable form of architecture because they can easily change to adopt people’s needs. Urban economies encourage less transport of the products and the aim of the sustainable city is to minimize the production of waste and its transportation. Instead of spreading, the intention of the contemporary city is to be more compact with higher density of population. Creating compact neighbourhoods will impact the whole city to become a compact settlement which will satisfy people’s needs without using unnecessary space. Open spaces will have their use and will not be just open space. Skopje, although it does not have the problems of the megacities, needs to redefine itself so it can exploit its whole potential. Skopje is not a big city, but it is an unused city. Therefore it is unsustainable and it must learn lessons from the problems of the big cities.

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Depopulation in Rural Towns of Sicily: A Historical-to-Present Day Analysis

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Abstract. Why in the last 50 years or so some rural towns in Italy have modestly grown while others have been inexorably losing inhabitants? This simple question informed a three-year research project carried out at University of Catania. The aim of our research was to investigate urban dynamics in southern Italian countryside against the rapid growth of nearby metropolitan areas. Using historical texts and maps as well as Geographic Information Systems we developed a taxonomy that aimed at characterizing the different patterns of population growth and de-growth in Sicily.

1. INTRODUCTION TO ECONOMIC, INFRASTRUCTURAL AND SOCIO-CULTURAL ISSUES OF RURAL AREAS IN SICILY: A HISTORIC BACKGROUND

In 1931 Renato Biasutti, the famous Florentine geographer, published a detailed report with attached maps on the state of Italy's countryside. In his report Biasutti, with a linear and descriptive approach, unfolded for the very first time the main infrastructural, social, and economic differences between Northern and Southern countryside of Italy: while the latter was greatly characterized by highly populated rural towns and large estates (the Latifondo), the former reflected a rather sparse urbanisation with middle-size, modern farms.

For centuries, in facts, the underdeveloped Sicilian latifondo (an Italian term for a large estate) represented the cornerstone of feudal government in southern Italy. A number of books, scientific and fictional, recent and less recent, have described the perverse outcomes of feudal rule on the island's politics, economics, and social tissue (De Stefano and Oddo, 1963). The first serious, although hardly unsuccessful, attempts to reverse the underdevelopment of Sicily's countryside began to be part of the government agenda during and after Mussolini's rule of the Italian peninsula (from 1922 to 1940). Building upon Biasutti's analysis, for scholars it was the physical structure of the latifondo that hindered the possibility to have efficient farms and better living conditions for Sicilian peasants (Coppola, 1938). For others, later on, countryside problems were not only infrastructural but more of a socio-political nature. In particular with a series of articles, today re-published in an invaluable book edited by Gorgoni (2005), Bernardo Rossi-Doria, the influent Italian economist, argued that revenues - collected in the form of expensive rents – were the main obstacle to improve living conditions in rural, southern Italy. This form of 'passive' income funding bishops, professionals, and aristocrats precluded any interests to improve countryside productivity and therefore peasants' income.

Despite a greater political autonomy gained by Sicily in the aftermath of WWII, very little was achieved to improve the lives of rural workers. The implementation of a plan to reform property and distribute land to peasants was at the best slowed, when not suffocated in a public bloodshed coordinated and carried out by unscrupulous organisations later to be named Mafia by the ancient landlords who didn't want or didn't like to share their wealth with poor, illiterate rural people (De Stefano and Oddo, 1963).

After many failed attempts to implement any form of development in the countryside, in the mid 1980's and 1990's, new legislative frameworks inspired by new concepts such as 'sustainable development' and later 'cultural landscapes' have facilitated plans aimed at preserving rural landscape and keep in place countryside population. In this fresh cultural environment, the Italian 'Territorialist School' of Alberto Magnaghi, an academic urban planner based in Florence, led the debate on territorialised and self-sustainable development, particularly with the rapid diffusion of his book "Il progetto locale" (2000, translated in English as "Urban Village" in 2005). Inspired by this new school of thought, planners have worked at new plans at the regional and sub-regional (provincial) scale to facilitate urban and landscape conservation as well as to advocate new forms of sustainable development in Sicily (La Greca et al., 2006). However, none of these plans have been fully implemented by the provincial and regional authorities and in newly re-organised political landscape of Sicily - where provinces have been abolished and budget slashed as consequences of 2008 global credit crunch - little hope is left to modernise or to protect Sicilian countryside against depopulation and risks related to climate change.

The aim of our research was to investigate urban dynamics in southern Italy countryside against the rapid growth of nearby metropolitan areas in Sicily. We have structured the next sections in the following order: in the second section we will introduce methodology and data sources; in the third section we will apply the chosen methodology to suggest a model to look at countryside dynamics in Sicily. In section four we discuss the results of our spatial/quantitative analysis. In the conclusions, we will sum up the results while sketching out two alternative scenarios for southern Italian countryside planning.

2. METHODOLOGY AND RESEARCH HYPOTHESIS

At the European scale research on rural development and landscape planning has been advanced by environmental planners such as Marsden (1995, 1998, 1999), Richardson (2000), Antrop (2000, 2004, 2005) and Courtney and Errington (2003). In particular Courtney and Errington (2003) have highlighted the need to stimulate self development in the countryside by paying more attention to the existing network of medium and small towns scattered in rural areas. Moreover, Antrop (2004) has suggested that the European rural policy is not properly addressing the specific issues of the different European rural regions. He has stressed the need to find out a congruent scale to investigate countryside and implement policies. Moreover, Antrop has argued that the European Landscape Convention (2000) is an important chance to build a relevant taxonomy of landscapes to territorialise future European policies. Working on these assumptions, Antrop and Van Eetvelde (2004) have studied southern French countryside, developing a GIS methodology to investigate agricultural intensification and urban abandonment. However, all these authors stress the importance to develop better methodologies to incorporate more variables in the analysis of rural-to-urban areas.

Building upon these studies, we have employed Geographic Information System (GIS) to develop a fairly-wide range of indicators which we have grouped into three macro themes: morphological-environmental, cultural-anthropic, and economic-demographic. Similar investigations have been carried out by the Territorialist School and Alberto Magnaghi for the Structural Plan for Prato Province in Italy (Magnaghi 2000, 2005a, 2005b, 2005c). From a spatial/geographic point of view, very little data about Sicilian countryside can be found in literature. The only material fairly updated (1996) and available material we have used in our analysis are the shape files of the ongoing works for the Regional and Provincial Landscape Plans. In particular a comprehensive island-wide GIS database has been created to provide an illustrated account of Sicilian natural environment, landscape, and socio cultural characteristics.

We have used these shape files to develop our morphological and cultural indicators. Anthropic, Economic and demographic data were obtained from the Italian national census bureau (ISTAT). GIS technology has been deployed to bring together both sources in a single platform for our analysis.

In particular we focused our research on rural towns of central Sicily with the aim to understand

why some municipalities have grown while others have been abandoned. Our work has been inspired by similar research been undertaken at Politecnico di Milano by Lanzani (2006) and associates (Lancerini, 2006). More in detail Lanzani has called slow territories those "...wide rural/semi-industrialised territories engaged in the production of high-value agricultural products within a very high standards natural and cultural landscape allowing to successfully brand those products while providing better quality of life" (Lanzani, 2006).

In our study we have expanded Lanzani's taxonomy by adding two more categories: fast-changing territories, where the speed of territorial dynamics related to urbanisation, environmental impacts, and economic development is high and chaotic; and long territories, a term that should connote those rural areas underdeveloped and increasingly abandoned. Because of the limited space, this article will touch on Fast-changing Territories and focus more in details on Slow and Long Territories.

3. LONG TERRITORIES IN SICILY: A QUALITATIVE UNDERSTANDING OF COUNTRYSIDE ECONOMIC AND URBAN DYNAMICS

The centre of Sicily is an astonishing beautiful and mysterious place. For centuries it has been exploited by the always-temporary masters of the island, residing in the more comfortable and accessible coastal capital cities (Palermo, Messina, Siracusa, etc.). Today, if we look closer at these places, we would notice that infrastructures are ruined, or rapidly deteriorating, and cities are largely abandoned. A shrinking population of elders is what remains of a once densely built rural towns.

Depopulation is a long-standing trend in the Sicilian countryside and can be traced back to the unification of the Italian peninsula in late XIX century. The first emigration wave (early XX century) led people to leave the island for the American continent, while in a second wave (1950's) Sicilians relocated to Northern Italian and European cities to power their industrial growth. A third, more recent wave is draining population from the countryside towards the main cities of the island such as Palermo, Catania, and Messina (Rizzo, 2004).

As result of this, the Sicilian countryside is agriculturally and economically underdeveloped as well as culturally and socially problematic. To characterise these territories we have deployed the adjective Long. Long Territories here stands not only for the physical dimension of remote rural areas but also for the lack of any form of development that could attract residents, entrepreneurs, and commercial activities. The lack of an efficient entrepreneurial tissue has been tackled without positive results since the 1970's with comprehensive plans facilitated by the regional authority for agricultural development (ESA, 1974). ESA's 28 local plans for Sicily contributed to provide some modern infrastructure to the countryside and in some cases it proposed cooperative models to increase production and wages. However these old generations of plans, very little concerned with budget provision and timeline implementation, proved to be a very expensive strategy for the regional government and thus rapidly discarded (Doglio and Urbani, 1972).

In their book titled "La fionda sicula" (in English: The Sicilian Sling, 1972), Doglio and Urbani criticised regional authorities policies and their extremely narrow planning. They use the metaphor of the 'island with a lake in the middle' to exemplify the lack of political initiative to boost development in the rural interior of Sicily. Against this scenario Doglio and Urbani proposed the "Absolute Island" in which development is instead powered from its centre and filtrated to the coast. After almost 40 years after Doglio and Urbani's book, the economics of Sicilian countryside has undoubtedly worsened. Today along with agricultural and urban abandonment other sicknesses have affected these territories such as increasing cruel episodes of youth violence and the re-emergence of agricultural slavery with sub-Saharan immigrants.

4. GIS ANALYSIS AND DISCUSSION

According to the Italian national census bureau database (ISTAT), the total population registered in Sicily in 2005 was 5,017,212 inhabitants, with an average-increment of 9,700 people per year between 2001 and 2005 (table 1).

Two-thirds of the total population inhabits in municipalities that are located below the threshold of 200 m above sea level (coastal towns); about one quarter lives between 201 and 500 m above sea level (semi-coastal towns); 17% lives in towns between 501 and 1000 m above sea level (mountainous countryside); finally, only 1% of the total population lives in villages above 1000 m.

It is also possible to observe that this proportion has remained stable between 1991 and 2005. By using GIS-based analysis it can be observed the same trend also for the population density. In the period from 1991 to 2005, in fact, cities located below the 200 m above sea level threshold increase their population from 428 to 436 inhabitants/sqKm), while cities between 201 and 500 m moved only from 153 to 157 inhab/sqKm. Finally, towns between 501 and 1000 m above sea level shrank from 84 to 81 inhabitants/sqKm as well as villages, from 38 to 37 inhabitants per square kilometre.

The morphological-environmental system (MES) has been subdivided in two groups: abiotic and biotic. In particular the analysis of the biotic system (figure 1) has been useful to elaborate a first understanding of the natural heritage of Sicily. From the results of this analysis we can observe a diffuse pattern of biotopes which are mainly distributed along the coast of the island but also in proximity of mountainous areas to the centre (Sicani, Pasquasia), west (Zingaro), and south (Syracuse). These systems overlap with wider regional parks and Special Protection Areas. Also they are intersected by a complex network of river basins and watersheds stretching through the whole island

The cultural-anthropic system (CAS) has been subdivided into four groups: land use, urbanised

land, infrastructure for mobility, and historical and cultural heritage. In the remainder of this paragraph we shall discuss the first two sub-components. The analysis of land use has shown that the urbanised areas in Sicily account for the 4% of the total area while 70% serves agricultural needs, 25% are natural areas (neither cultivated nor urbanised) and 0.3% are water basins. Within this frame, it has been possible to identify the following landscape typologies (figure 2): volcanic (Mount Etna), non-intensive cultivated area (mainly grains), forest land (Peloritani, the north-eastern vertex, Nebrodi, and Madonie), intensive cultivated areas (vineyards in Trapani, Agrigento, and Ragusa), and citrus fruits orchards (scattered along the Ionian coast, Agrigento, and nearby Catania). By further analyzing the patterns of urbanisation it has been possible to understand that the coastal areas have high ratios of urbanised land which accordingly grows in proximity of the three metropolitan areas of Palermo (about 600,000, metro about 800,000 inhabitants), Catania (about 350,000, metro about 700,000 inhabitants), and Messina (about 250,000, metro about 350,000 inhabitants). Sparse urbanisation can be found extensively in the province of Trapani and between the cities of Agrigento and Caltanissetta while compact urbanisation is a characteristic of rural towns of the countryside.

Table 1. Population in Sicily by altitude (source: ISTAT, 1991-2005).

Altitude ranges	1991	2001	2002	2003	2004	2005
0 - 200	2.929.951	2.957.984	2.954.937	2.974.537	2.980.709	2.982.883
201-500	1.102.412	1.106.852	1.113.605	1.122.912	1.127.757	1.131.146
501-1000	895.756	868.754	868.574	871.069	870.094	868.954
> 1000	38.267	35.401	35.008	34.744	34.521	34.229
tot.	*4.966.386*	*4.968.991*	*4.972.124*	*5.003.262*	*5.013.081*	*5.017.212*

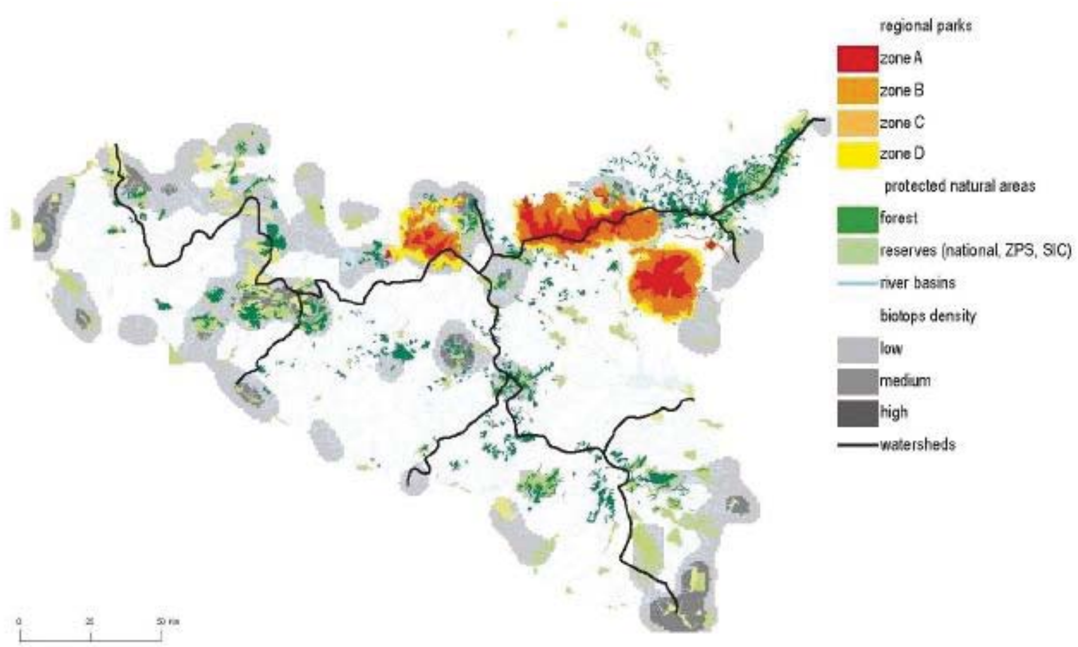

Fig 1. MES: biotic system map (source: our elaboration based on PTPR, 1996).

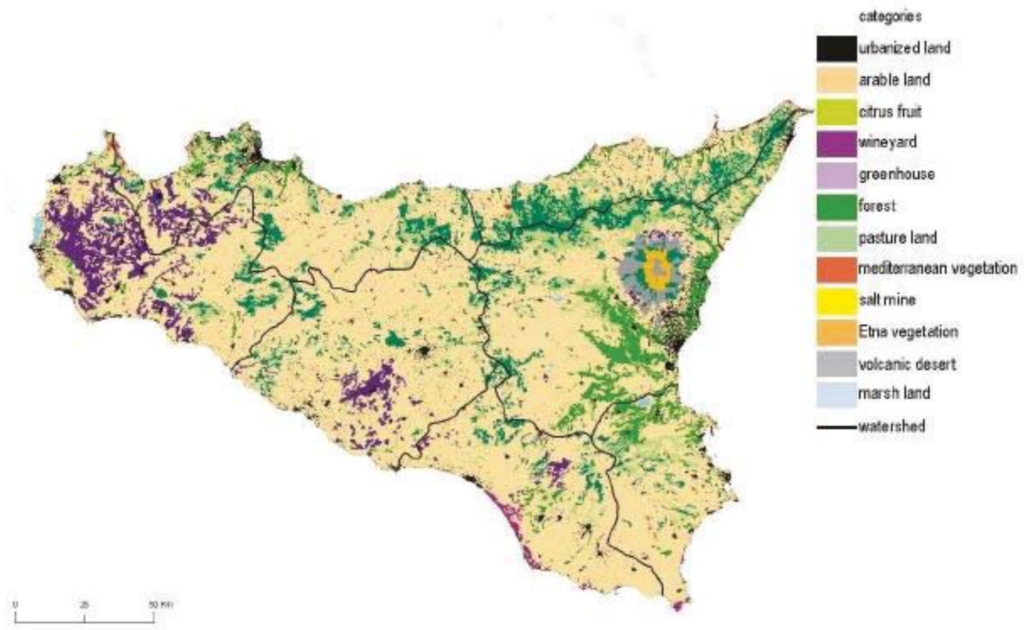

Fig 2. CAS: landscape typology map (source: our elaboration based on PTPR, 1996)

With regards to the economic-demographic system (EDS) we shall discuss the recent migration trend. An analysis of demographic data of the 2002-2005 series shows a steady loss of countryside population in particular in the provinces of Enna, Messina, and Caltanissetta, while other areas have registered positive migration trends. Those latter areas are characterised by efficient economic activities such as agro-industries (wine and vegetables) and “slow” tourism hubs such as in Ragusa, Modica, Trapani, and Siracusa.

Finally, we have overlapped the three previously mentioned systems to extract further information about our case study. The major linear infrastructures facilitating the distribution of energy and traffic generate a non-urbanised network of potential greenways intersecting both natural areas and metropolitan conurbations. Furthermore, the major concentration of wealth can be found in the heavily urbanised coastline. However, two observations can be made: the distribution of income is unequal along those coastal regions (i.e. in the north-coast incomes are lower than in the east coast – this depends on the location of metropolitan areas); rich areas can be found in the countryside too (Caltanissetta, Enna, and Nebrodi).

Building upon the above mentioned analysis and the geographic distribution of activities of the first, secondary, and tertiary economic sectors we have come up with the following urban/regional typologies (figure 3):

- A1 it groups the metropolitan areas of Palermo and Catania, both having a large number of local units employed in tertiary and advance services (fast-changing territories type 1);
- A2 it contains cities having industrial as well as tertiary activities such as Messina and Syracuse (fast-changing territories type 2);
- A3 it identifies industrial agglomerations serving metropolitan areas (Milazzo, Termini Imerese, and Gela - fast-changing territories type 3);
- A4 it groups cities having a small number of employees in the industrial sector (fast/slow territories);

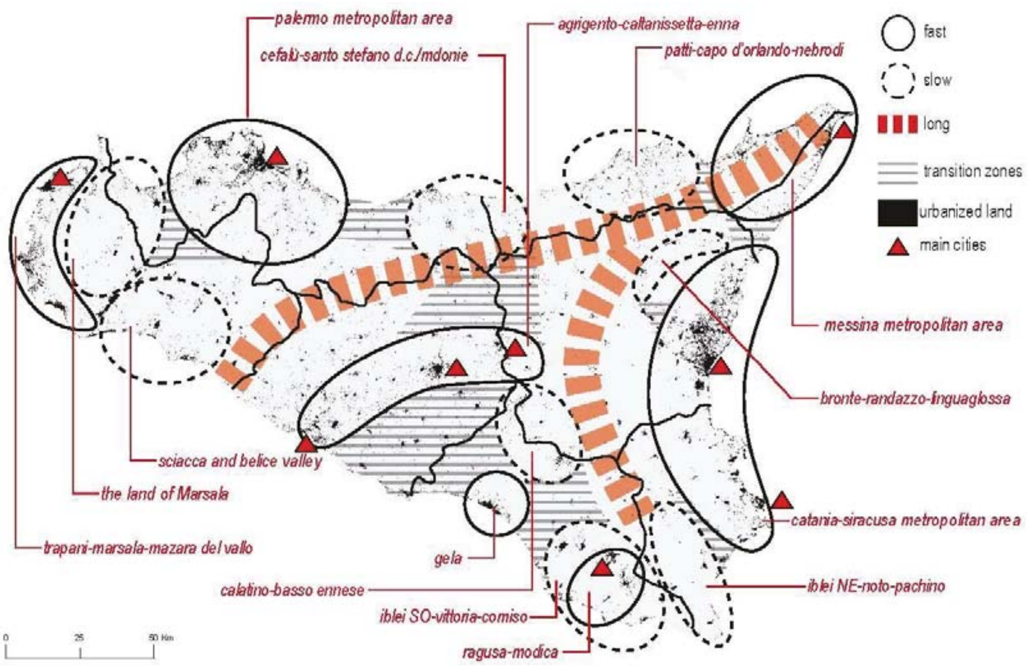

Fig 3. Synthesis map: fast, slow, long territories

- B1) it encompasses those cities investing important resources in tourism as well as in agro- industrial activities (Enna, Taormina, Acireale, Giarre, Lentini and Victoria - slow territories);
- B.2) and B.3) contain those towns in which the economic tissue is based on the primary sector (potential slow territories and long territories).

5. CONCLUSIONS AND TWO SCENARIOS

In this article we have discussed the developmental problems of rural areas in Sicily and proposed a taxonomy that helped understand both past and current economic/urban dynamics. We have proposed to call Fast-changing Territories those established as well as emerging conurbations which attract intra-regional migration flows. In these areas the speed of territorial changes is higher than anywhere else in the island.

Other researchers such as Lanzani (2005) have introduced the category Slow Territories,

understanding with this term those regions attracting both inhabitants in search for better quality of life and modernised rural activities. A great part of the Italian countryside could potentially be a slow territory; however, very few areas in Sicily and in Italy have reached this status. In particular, it seems that slow territories beside metropolitan areas have better chances to succeed due to their better connectivity with advanced urban services (R&D institutes, airports, etc.).

Most areas of the Sicilian and southern Italian countryside are, in our understanding, Long Territories - economically, socially, and environmentally problematic. High rates of depopulation, impoverishment of social and environmental capital, and lack of political will are the main constraints hindering the urban/economic development of Long Territories in Sicily.

Based on our GIS analysis we have suggested to understand as fast-changing territories those urbanised regions stretching along the Ionic cost (Siracusa-Augusta-Catania-Messina) and around the capital city (Palermo-Termini Imerese-Partinico). Slow territories, on the other hand, are the less dense populated urban regions having agro-industry and tourism as main economic drivers (Trapani- Marsala-Mazara del Vallo, Ragusa-Modica). Migration net flow in those latter areas is positive. Finally, Long territories are those depopulated, underdeveloped, and inaccessible areas located in the interior part of Sicily (Agrigento, Caltanissetta, and parts of the provinces of Messina, Catania, and Palermo).

By using this taxonomy, it can be overcome traditional “Rural versus Urban” planning rhetoric and engage with a much more useful model which distinguishes between fast, slow, and long territories. Of course a certain degree of caution and flexibility should be adopted when labelling fast, slow or long territories. Also, a comparative research considering other rural areas in southern Europe could useful to extend our research results. Statistics show that an increasing amount of people is looking for alternative lifestyles. In this perspective I think that long territories in developed countries must be re- considered because, firstly, Fast-changing territories cannot alone carry out the increasing demand for services while guarantying high standards of living and, secondly, Long territories, on the other hand, have great potentials, to provide better services in particular for certain population groups such as alternative and ecological responsible communities, children and elders, etc.

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How Should we Deal with Socio-Economic Values in Development Decisions?

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Abstract. When the feasibility of a proposed property development is being considered, a cost-benefit analysis is typically done. This approach contains a number of fundamental problems, including that of definition of the appropriate metric or metrics, identification of the motives, values and interests of the decision-makers and the stakeholders, identification of appropriate discounting techniques, as well as the problem of trans-generational discounting. The underlying challenge is to render values susceptible to analysis in economic contexts, especially in a society where there are widely divergent views on value systems. These and related issues are addressed by investigating the methodological principles involved. An overview is given of the diversity of theoretical values involved in making a development decision and different approaches to address the impact of a decision. It is proposed that societal values emerge through the interaction of many heterogeneous interacting agents.

1. INTRODUCTION

The use of cost-benefit analysis (CBA)is widely practiced today, notably in the fields of development and environmental policy, or when the feasibility of a proposed property development is being considered. Essentially benefits are compared with costs, where benefits are defined as increases in human well-being (utility) and costs are defined as reductions in human well-being. Future benefits and costs are discounted to the present to ascertain whether the present benefits exceed the present costs.

In order to give “utility” (i.e. “value”) an operational definition, it must be expressed in quantifiable terms. Money is generally used as the metric.

This approach contains a number of fundamental problems, including that of definition of the appropriate metric or metrics, identification of the motives, values and interests of the decision-makers and the stakeholders, identification of appropriate discounting techniques, as well as the problem of trans-generational discounting - e.g.. A number of the more important of the numerous critiques of CBA are summarized in.

The philosophical issues in cost–benefit analysis that emerge in the three major phases in the process leading up to a finished CBA are highlighted in: (1) the framing of the decision, that determines which decision alternatives are included in the analysis; (2) the option characterization, i.e. the delimitation of the consequences of these alternatives that will be subject to valuation; and (3) the valuation of these consequences. A number of these issues are also addressed in.

CBAis, in itself, blind to inequality. This is because it is based on the assumption that the objective is utility maximization irrespective of the distribution of that utility. The CBA methodology can be adjusted relatively easily to incorporate “aversion” to inequality by simply weighting the calculation according to who pays, and whom it benefits. Although technically easy, it does lead to ethical difficulties. The degree of inequality aversion to be incorporated will be subject to contested views and different value judgements.

However, the primary purpose of the present paper is not to assess all the merits or shortcomings of these criticisms, but rather to address a more fundamental issue: How to reach a decision when values are incommensurable and we lack an algorithm that reduces them all to the same scale? How to deal with social decisions in societies where widely divergent and even disparate values are held by different interest groups?"What if moral, social and cultural values were to play a critical role in economic processes? …..Would we be able to stick to the customary road of rational choice or is there another road to travel, like a road of evaluation?".

2. METHODS TO INCORPORATE NON-MONETARY VALUES

Two methods that have been developed to incorporate non-monetary values are the *SROI (Social Return on Investment)*and the *Analytical Hierarchy Process (AHP).* The main characteristics of these two methods will be sketched, after which the problems of dealing with values will be addressed.

2.1. Social return on investment (SROI)

The Social return on investment (SROI) is an outcomes-based method for measuring non-monetary values. Developed from traditional cost-benefit analysis and social accounting, SROIcan be defined as a framework for measuring and accounting for the much broader concept of value. It seeks to reduce inequality and environmental degradation and improve wellbeing by incorporating social, environmental and economic costs and benefits. It is a participative approach that attempts to understand and quantify the social, environmental and economic value organizations are creating. The conduct of each SROI analysis is based on seven principles:

i. Involve stakeholders. Stakeholders should inform what gets measured and how this is measured and valued.
ii. Understand what changes. Articulate how change is created and evaluate this through evidence gathered, recognising positive and negative changes as well as those that are intended and unintended.
iii. Value the things that matter. Use financial proxies in order that the value of the outcomes can be recognised.
iv. Only include what is material. Determine what information and evidence must be included in the accounts to give a true and fair picture, such that stakeholders can draw reasonable conclusions about impact.
v. Do not over claim. Organisations should only claim the value that they are responsible for creating.
vi. Be transparent. Demonstrate the basis on which the analysis may be considered accurate and honest, and show that it will be reported to and discussed with stakeholders.
vii. Verify the result. Ensure appropriate independent verification of the account.

Central to the CROI approach is the allocation of financial 'proxy' values on all those impactswhich do not typically have market values. In essence, it is assumed that price is a proxy for value. This highlights the biggest single shortcoming of the CROI approach: Some outcomes and impacts (for example, societal stability, environmental values) cannot be easily associated with a monetary value. In order to incorporate these benefits into the SROI ratio proxies for these values would be required. However, as emphasizes: " …fixation on economic values, practical as it may be, …cannot account for a great deal of human interactions…. Economic values as the be all and end all of things does not make sense"

2.2. The Analytical Hierarchy Process (AHP)

Assigning a monetary value to the social impact can be difficult. Various methodologies have been developed to help quantify impact: the Analytical Hierarchy Process (AHP), for example, is one method that converts and organizes qualitative information into quantitative values [10]. It is a structured technique for analyzing decisions, for example the selection of an alternative from a number of alternatives, usually when multiple decision criteria are applicable. Multiple-criteria decision-making (MCDM)endeavours to structure and solve decision and planning problems by involving multiple criteria. Typically, it is necessary to use decision maker's preferences to differentiate between solutions. Normally the decision-maker has to "tradeoff" certain criteria for others.

The AHP derives ratio scales from paired comparisons. The input can be obtained from actual measurements such as price, carbon emissions, etc., or from subjective opinions such as feelings and preferences. The AHP is a method that can be used to establish measures in both the physical and social domains: both tangibles (that can be measured) and intangibles (relating to subjective ideas and beliefs of the individual about himself or herself and the world of experience.

The procedure for using the AHP can be summarized as:

- Model the problem as a hierarchy containing the decision goal, the alternatives for reaching it, and the criteria for evaluating the alternatives.
- Establish priorities among the elements of the hierarchy by making a series of judgments based on pair wise comparisons of the elements. For example, when comparing potential purchases of commercial real estate, the investors might say they prefer location over price and price over timing.
- Synthesize these judgments to yield a set of overall priorities for the hierarchy. This would combine the investors' judgments about location, price and timing for properties A, B, C, and D into overall priorities for each property.
- Check the consistency of the judgments.
- Come to a final decision based on the results of this process.

2.3 .Criticism of the SROI and the AHP

It is apparent that both the above methods assume rational agents operating in a world of perfect information, i.e. the model of classical economics: Economic phenomena at a macroscopic level are to be explained as being based on the choices made by independent individual decision makers, leading to equilibrium as the final (desired) state.

The actual behavior of agents, however, appears to disconfirm the assumption of the rational economic decision-maker: that all agents conform to cardinal or ordinal utility rankings or preference orders and that they always choose the alternative that maximizes their utility or preferences.

3. VALUES

3.1. The nature of values

Values refer to enduring beliefs that we hold concerning modes of conduct or end-state of existence in different situations, societies and cultural contexts. Values act as goals, criteria or standards that guide and give direction to our actions, judgments and decisions .

A plurality of values exists, including those that are aesthetic, spiritual, social, symbolic, and historical. In a similar context, conservation professionals do not share a core set of values and goals. "In reality, most conservation professionals draw on a range of values, from the intrinsic values of species to the use values of nature to humans. We consider it likely that such diverse views exist across a wide range of individuals and organizations involved in conservation …We believe conservation science and practice should not try to create a consensus under which conservation professionals can unite and instead acknowledge the diversity of opinions in the field."

Weston concurs with the viewpoint that rather than exploring the validity of inherent or intrinsic values, environmental ethics needs to scan all the values of decision-makers and interpret them together as an "ecology of values." Weston's ethic suggests that the ultimate "grounded" value may be as much in the interdependence between values as in the value itself.
In addition to the plurality of values, values are typically not static: values may change. People develop values and adopt new ones. Values are not fixed as the standard economic model postulates; they change in the process .“Preferences, it turns out, are actually constructed—not merely revealed—during their elicitation. And the construction of preferences appears to be sensitive to various aspects of the decision problem…. Different frames, contexts, and elicitation procedures highlight different aspects of the options and bring forth different considerations, which often give rise to inconsistent decisions.”

We thus have two problems in principle when trying to incorporate values in the decision-making process: that of the multiplicity of values (resulting in, *inter alia*, the problem of comparative measurement) and that of the dynamic nature of values. The strictly economic perspective is useful to highlight the costs and benefits to the parties involved, but is in the final analysis a limiting framework. Consideration of the impact of development decisions on society or the environment requires a different approach – an approach that, firstly, takes cognizance of the irreducible plurality of human ends and that substitutes for aggregate utility the generic concept of a general good and, secondly, that recognizes the fact that at least some values, whether personal or societal, may change over time.

3.2. Societal values as emerging from participation

A comprehensive overview of our current understanding of social sustainability, concludes that ...”the assessment and measurement of social sustainability are still dominated by the holistic versus the reductionist approach debate, which is unlikely to be resolved in the near future, and argues that a new breed of indicators containing a perceptual component is increasingly being suggested for sustainability policy prescriptions. In terms of sustainability tools…these are often based on monetisation and accounting techniques that do not take into account the participation element of social sustainability.”.

In a similar context, it is cautioned that “…instead of worrying about which method to adopt in order to best capture stakeholders’ needs, or what methods can strengthen stakeholders’ ownership and commitment … the main concern should be on how methods can be best used to work with values. In short, this requires us to view methods and participation as means to achieving ….a core engagement with values.”.

Three main arguments can be put forward for the importance of participation for the social sustainability of communities and place: (1) participation allows for communities to express their needs and aspirations, which subsequently feed through the policy making, delivering and monitoring processes. This also results in collaborative governance, (2) the democratic right to be involved in the public policy process is an intrinsically good quality of societies, and (3) the greater effectiveness of policy delivery if it is “more in tune with society’s values and preferences” and could thereby result in “better” policy delivery .

4. COMPLEX SYSTEMS AND VALUES

In order to make some progress, albeit limited, through the quagmire of viewpoints on the value problem, it is proposed that values are better described in terms of complexity economics rather than in terms of traditional economics: patterns and possibilities in open, dynamic, non-linear systems determine values rather than prices and quantities in closed, static, linear systems in equilibrium. Networks of relationships between heterogeneous agents change over time and macro patterns are the emergent result of micro level behaviours and interactions. The evolutionary process of differentiation, selection and amplification provides the system with novelty. Complexity economics “…sees the economy not as a system in equilibrium but as one in motion, perpetually “computing” itself—perpetually constructing itself anew. Where equilibrium economics emphasizes order, determinacy, deduction, and stasis, this new framework emphasizes contingency, indeterminacy, sense-making, and openness to change. There is another way to say this. Until now, economics has been a noun-based rather than verb-based science. It has pictured changes over time in the economy function as changes in levels of fixed noun-entities—employment, production, consumption, prices. Now it is shifting toward seeing these changes as a series of verb-actions—forecast, respond, innovate, replace—that cause further actions. This shift …redefines what constitutes a solution in economics. A solution is no longer necessarily a set of mathematical conditions but a pattern, a set of emergent phenomena, a set of changes that may induce further changes, a set of existing entities creating novel entities." A review of applications of the complexity theory to economics is provided in.

Viewing the economy as a complex and adaptive system with many heterogeneous interacting agents provides an explanation of phenomena such as "phase transitions". In linear models prevalent in the reductionist models of classical economics, all system properties can be derived by adding up the properties of its elements. Emergent phenomena (i.e. fundamentally new and qualitatively different system properties) can be explained by non-linear models only, where effects are not just cumulative and not proportional to causes. The interaction of many heterogeneous interacting agents leads to empirical regularities, which emerge from the system as a whole and cannot be identified by looking at any single agent in isolation.

It is postulated that some values, at least societal values, emerge from the interaction of the participants in that society and are therefore multivalent and dynamic. Whereas some values seem to be more or less stable (e.g. fairness and justice, compassion and charity, duties and rights, human species survival and human well-being), other values may change over time, analogous to changes in political and opinion formation. Recognition of the basic nature of values is essential for the development of decision-making models that correspond to reality. The human motivation system should not be described as "a coldly calculating utility-maximizing algorithm"; and equally decision-making does not comprise the creation of a list of all possible worlds and assigning a value to each of them.

It therefore seems appropriate, and indeed advisable, to investigate the incorporation of values in economic decision-making models through the application of complex systems concepts. Such an approach also holds the promise of providing a common framework for economic decisions and sustainable development.

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Sustainable Mobility, Livability and Public Space in Historic Village Cores – a Case Study of Lija, Malta

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Abstract. Since the 1990s the Structure Plan for the Maltese Islands has sought to guide planning in Malta to encourage socio-economic development, to promote the efficient use of land, and to help improve the environment. The early 90s also witnessed the introduction of Local Councils, representing a first step in the devolution of central state powers. Amongst their more operational functions within urban areas, the Local Councils are intended to upkeep, maintain and improve roads, to establish and maintain open public spaces, pedestrian and parking areas, and to propose changes in traffic schemes. This paper presents the case study of Lija, a historical village in Malta, and the process involved in the development of a sustainable urban environment strategy. The objectives of this paper are; (i) to describe the situation in Lija and assess the potential for improving livability, (ii) to document the development of a strategy for sustainable mobility and enhanced quality of life, (iii) to identify the challenges and gaps in the planning and regulatory framework for proposals by Local Councils. The study uses surveys for the collection of base data and direct observation, with the authors being involved in the development of the strategy. Results show a considerable number of challenges that inhibit Councils' abilities to be pro-active about their localities' futures.

1. INTRODUCTION

Sustainable mobility is concerned with leveling economic, social and environmental impacts of transport that define and influence cities today and in the long term. Studies on livability on the other hand reflect on the impacts on communities of the effects of development, such as increased threats to public health, air and noise pollution, affordability and shifting property values, equity and so on. Several factors affect livability including the quality of the environment, whether urban or rural, the social structure, mix and compatibility of the community, the standard of properties and availability of facilities and supporting infrastructure, economic stability and work opportunities. The relationship between accessibility, transport sustainability and livability is nevertheless also very strong, with some sustainability objectives such as pollution reduction having a direct impact on livability. In the context of urban regeneration, livability refers to the ability of a centre to maintain and improve its viability and vitality. An important element of livability is the presence of green areas within the city that contribute to quality of life. Public urban open spaces, in the forms of piazzas, squares, small gardens or landscaped parks provide important social and psychological benefits to communities. They enrich life, and fill it with meanings and emotions. This paper takes a look at one typical village centre and addresses the importance of sustainable mobility, livability and open public space for the well-being of communities and the sustainability of Maltese village cores. The delivery of new spaces is considered important for the development of socio-cultural interactions which lead to community development, fostering sense of place and supporting the development of sustainable communities.

Malta's dense population is primarily contained in 68 urbanised centers governed by local councils. With the exception of a few 'modern' towns, most localities have a historic village core which is protected by law and designated as an Urban Conservation Area (UCA) in planning policy documentation. These UCAs reflect the islands' heritage and history. They are characterized by narrow streets and picturesque urban features generally with the community parish church at the centre facing onto the main village square. Council offices, being of recent introduction have, with few exceptions, not yet gained the necessary status and respect within village society to warrant a space on the main square, next to the grandest residences, the band clubs and the political parties' clubs.

Malta is very car dependent, having one of the highest motorization rates in Europe and the world. The growth in car ownership evidently paralleled the economic growth experienced in the islands over the past twenty years, but is also a reflection of an as yet insufficient public transport infrastructure and a weak transport policy, which for too long concentrated investment solely in infrastructure for the private car. This focus has led to a strong predict-and-provide approach to supply more infrastructure for the ever increasing demands of a growing car dependent population. This has led to the erosion of road space and public urban space for any other use, except the car. The end result is what Gehl and Gemzøe term an 'invaded city', the complete domination of the urban area by cars and the allocation of otherwise public open spaces and walkways to parked cars and wider roads to support increasing volume and speed. This is further exacerbated in the old historical village cores where space is even more limited and the infrastructure cannot cope with increasing pressures. Conflicts between cars and people occur and this is leading to exclusion, poor social and physical environments and a lowering of quality of life.

This paper looks at the case study of Lija, a small historic village in the central region of the island of Malta. Like many of the historic centres described previously, Lija has fallen victim to through traffic, as well as a consistent erosion of open spaces and safe public walkways. The objectives of the study are to (i) to describe the situation in Lija and assess the potential for improving livability, (ii) to document the development of a strategy for sustainable mobility and enhanced quality of life, (iii) to identify the challenges and gaps in the planning and regulatory framework for proposals by Local Councils.

The next section looks briefly at the relevant literature focusing on the relationship between open spaces in urban areas and quality of life. Section 3 presents the methodology whilst Section 4 presents the results. Section 5 concludes the paper and identifies the challenges faced by Councils, but also provides some insight into further research in the area.

2. SUSTAINABLE MOBILITY AND URBAN AREAS

Consensus on the definition of sustainable mobility was reached in the 2004 European Commission's Thematic Strategy for the Urban Environment[1]. In this document the European Commission recognizes that traffic has significant impacts on the environment and health of urban citizens and the overall quality of life in towns. The layout of the urban environment also has implications on mobility, and therefore on community health, well-being and urban livability. This has been the object of academic debate for a number of years.

The issues surrounding critical natural capital and sustainability have been studied extensively with results suggesting a strong link between human-nature relationships and the benefits of nature based experiences in the public space. These occur through different functions whether recreational, scientific and educational, cultural and historical or religious or artistic information. Others have looked at the relationship between patterns of space use, especially outdoor activities, and the spatial properties of the physical environment. Gehl promoted a straightforward approach to improving urban form, which he did through a systematic documentation of performance of urban spaces and analyzing what factors influence urban environments by quantifying the level of pedestrian flows and activities, including human contact and social interaction. This theoretical framework (Figure 1) was applied to the study and its principles translated into the strategic plan for the case study of Lija.

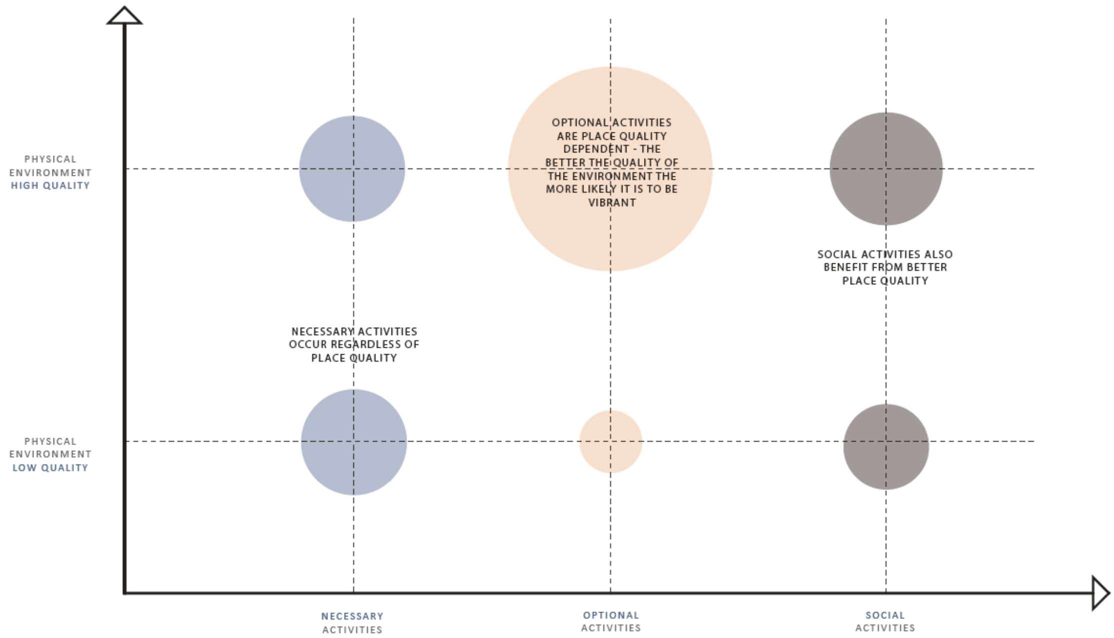

Fig 1. Theoretical framework underpinning the strategy plan for Lija. Adapted from.

3. THE METHODOLOGY

The study applied a series of techniques tocollect the necessary information about the locality. Primary data was collected from the field whilst secondary data was retrieved to ensure consistency of the proposed strategy with existing policies and documents. Table 1 summarizes the data collection methods used for the study. The outputs of the data collection are also listed, even though it was not possible to include all of these in this paper due to space limitations.

Table 1. Type, method and output of data used for the study.

Type of Data	Method for data collection	Output
Network and Traffic data	Traffic surveys at junctions and entry/exit points of locality. Network information (traffic direction) mapped on site.	Simulation of traffic using AIMSUN software under different scenarios
Parking data	Field survey mapping parking spaces and parked cars in the locality	On-street parking capacity, mapped using Q-GIS Software
Land use data	Field survey mapping land uses in the locality	Land use map using Q-GIS Software
Land ownership data	Requests sent to Government Lands Department	Identification of potential sites for parking infrastructure
Public transport information	Bus route data extracted from Malta Public Transport website	Map data
Street visuals	On site observations and photography	Street profiles
Planning policies	Sourced from *Structure Plan for the Maltese Islands*and from the *Central Malta Local Plan.*	List of relevant and site specific policies

4. THE CASE STUDY OF LIJA

In 2013 Lija registered 3,039 inhabitants. With an area just over a square kilometer, it is one of the smallest localities in the islands. It has a very old and designated urban conservation area and lies at the edge of the urban agglomeration spanning the inner and outer harbour regions. A substantial area within the locality boundaries is designated as out of development zone and its newer residential areas built primarily in the 1970s and 80s are quiet one to two floor residential areas with very low density.

The urban conservation area of Lija is characteristic of many other old, historical villages in Malta. Narrow streets that were not designed to cater for cars lead to the main church and square and are ill fitted for parking and high speed (of traffic). In addition to this, and partly due to its location in the region's transport network it also receives a relatively high volume of traffic in its narrow streets (in some cases as narrow as 5m). This gives rise to issues related to safety, pollution, access to the public road by residents and visitors, and overall quality of life within the locality. In addition to this there is very little appreciation of the urban space as it is plagued with parked cars taking up precious space in narrow streets and small squares. This makes walking for example very difficult, uncomfortable and dangerous.

As described in Section 3 an initial mapping of the locality was carried out with regard to traffic volume and direction, parking spaces and capacity, public transport services and land use. Whilst the traffic count data confirmed the high traffic volume during morning peak hours, parking surveys showed clearly the "invasion" of cars within the locality (see Figure 2). Public transport services are limited in the area, traditionally because of the limitations of the narrow streets to accommodate relatively large buses used in the service.

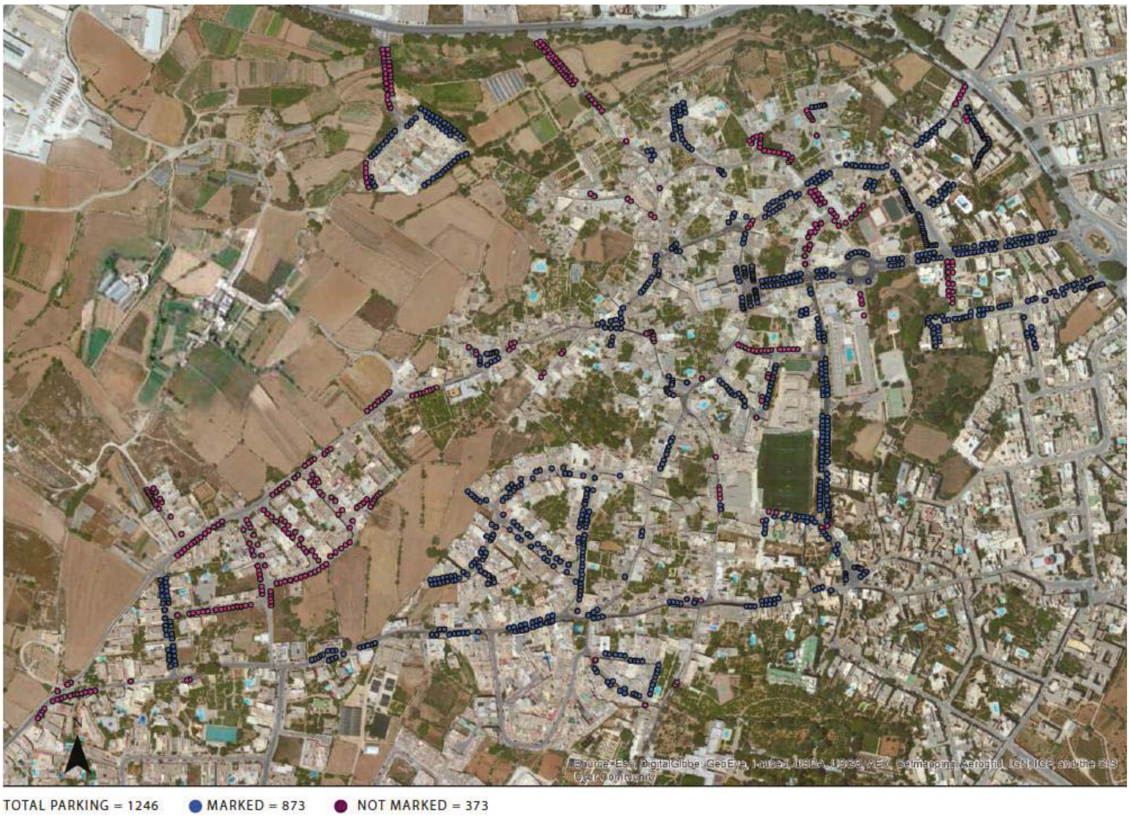

Fig 2. Parking survey results for Lija.

4.1. State and regional policies

The 1990 Structure Plan for the Maltese Islands identified a number of policies to improve the quality of the urban environment. Policy BEN19 recommended the development of a detailed policy for open space standards, implementation and maintenance, whilst Policy RDS7 recommended extending pedestrian priority and access only restrictions in Urban Conservation Areas. Other policies looked at the preservation of architectural and historical buildings and townscapes (UCO06) and the creation of safe and more congenial environment for pedestrians (UCO14). Environment policies also stressed the importance of rationalization and control of traffic movement and parking (clause 3.10) and the creation of *new urban areas which are a pleasure to live and visit* (clause 3.12) .

The 2015 Strategic Plan for the Environment and Development (SPED) aims to develop urban areas as attractive places for people to live, work, play and interact, particularly historic cores which *shall become vibrant and their townscapes harmonious*. It refers to economically dynamic and walkable neighbourhoods and identifies the lack of urban green spaces and the invasion of parked cars as hindering healthy lifestyles and community identity. It again refers to the dire capacity of narrow streets to handle traffic and parking. This complements both the 1990 Structure Plan and the 2006 Central Malta Local Plan which identified, amongst other, the need for traffic calming in Lija to ensure safe passage for pedestrians (and cyclists) and improve the visual amenity in the urban core.

4.2. The strategic plan for Lija

Following on from approved policies for the area and locality, the study team identified three main areas of concern, primarily to (i) limit traffic, (ii) prioritise the pedestrian and (iii) enhance and expand public space. Figure 3 represents the objectives and actions which are contained in the strategy.

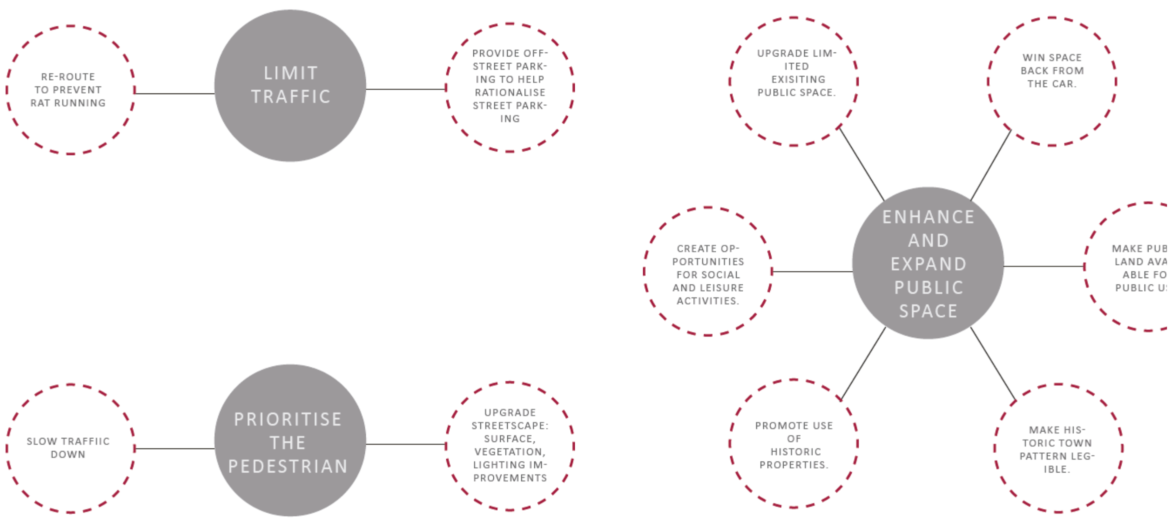

Fig 3. The strategic plan for Lija.

4.2.1. Limit traffic. In order to achieve this objective two main actions were proposed including that of re-routing traffic to prevent through traffic from Mosta to Birkirkara. Lija is located between two major thoroughfares and with its current traffic routing serves as a by-pass to several junctions. Another action included the identification of land areas which could potentially serve as off-street parking areas, surrounding the urban core. Properties were identified and information sought from the Government’s Land Department and Local Council. In the end five sites were identified with a capacity of 850 parking spaces. These included government owned land, but also private land which is well-located to serve neighbouring areas. Geographic analysis was carried out to establish potential area coverage of these parking areas and access to the urban core and areas within the locality. In this manner it was established that all areas within the locality had access to a parking area within 500m walking distance.Such capacity would also support the removal and replacement ofa substantial number of parking spaces (over 800 marked in blue in Figure 2) within the historic urban core.

4.2.2. Prioritise the pedestrian. In this case two streets were taken as case study examples of pedestrian access and townscape improvements. One street, Triq il-Mirakli represented a relatively modern, wide street within the newer areas of development in Lija, whilst TriqSant' Andrija was used as an example of the village core, with a narrow winding character and little to no facility for pedestrians. In both cases proposals were drawn up to re-design the street facilities for parking, extend and improve the pedestrian environment and introduce, where possible, trees that provide some green but also shade and shelter for pedestrians in the hotter months. Figure 4 shows some details of the designs for the two streets.

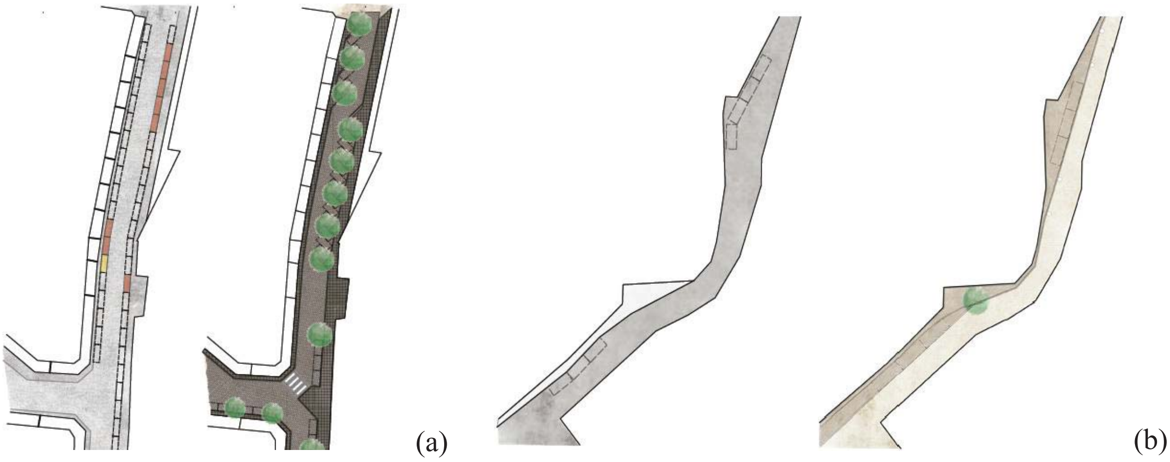

Fig 4. Section details of Triq il-Mirakli (a) and TriqSant' Andrija (b).

4.2.3. Enhance and expand public space. Twelve open spaces were identified in Lija, including relatively small squares in the urban conservation area, areas surrounding important historical buildings and existing gardens which currently service the community or are in private ownership. In this case all the areas identified in the plan have the potential to act as areas for local pedestrian activity, community interaction and play areas. These squares would also enhance the pedestrian experience as one traverses the village core. In order to demonstrate some of the concepts related to the third objective of the study the team drew up plans for the re-development of the square facing the main church into a pedestrian area and the conversion of a garden in Merino Street into a square, opening up precious space in the otherwise very dense urban core. Other potential areas include the square outside Villa Francia which is currently used as the Prime Minister's official residence. Figure 5 shows an artist impression of the main square.

5. CHALLENGES AND FURTHER RESEARCH

> *"In the history of the 20th century city an assassination has taken place. The name of the victim: the urban street." With these strong words Giancarlo Consonni recently called our attention to the destructive action of modern contemporary practices of urban development in respect to the street as a synthesis of the "many ways of tampering with and degrading open public spaces that aim at murdering the living body of the city, taking away its very essence, what it represents in the history of civilization".*

Fig 5.Lija Church and main square today and following intervention to enhance public space.

This study has attempted for the first time to investigate the causes and concerns of historical urban cores today. This was done through field investigations and the development of a strategic plan for the sustainable urban development of the locality of Lija.

The plan was ultimately presented to the Lija Local Council. Following a number of meetings with the Local Council, and subsequently with Transport Malta and the Malta Environment and Planning Authority, the two national regulatory bodies responsible for transport and land use, it is evident that there are a number of challenges which the Local Council will face in order to implement the plan as described in this paper. Primarily, Local Councils are not allocated funds to support such studies and development of strategic plans for their localities. Such plans fall within the remit of the national planning authority, which however, has never really engaged with this function and today is largely limited to the processing of development applications. Transport Malta on the other hand is responsible for main arterial and distributor roads; local access roads, such as the ones found in Lija do not fall under its responsibility. TM is approached by Local Councils for the approval of design concepts but would not interfere or propose measures at local level.

This situation is a challenge as the Lija Local Council is now left on its own to implement a locality wide strategy that requires significant funding and support. The Local Council is seeking the residents' views and approval on the plan and hopes to propose it to Government as an example of best practice, to obtain funding. It is unclear at the time of writing whether the Local Council will ever be in a position to implement the necessary measures to see the strategy through. Formal conversations and observations do not lead the study team to believe that institutional structures are currently in place to facilitate such an approach. This will be the first major challenge faced by the Local Council.

Secondly there are issues of funding, however this has already been identified as a potential project for European funding under sustainable urban environment initiatives with funding schemes such as CIVITAS or ERDF being two possible funding sources. The Council however requires substantial investment in human resources and capacity to be in a position to apply and subsequently deliver on such a project.

This study has brought to light some of the more pressing concerns and issues within Malta's historic urban environments. The methodology for developing the strategic plan has shown itself to be successful in providing the necessary background information to identify the problems and propose possible solutions. Further research will be required to look at the institutional structures and relations, which currently support such initiatives at both local, regional and national government.

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Sustainability in Development Planning

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Abstract: The basis of a legally established planning process is founded on predetermined goals that should reflect the sustainable principles that every democratic society has a right to achieve. That is why the economic, social and environmental pillars of sustainability need to be transposed in every legally binding policy document and equally important being actually reflected on the ground. However Development Planning tends to be complex in nature and as a result, can be difficult to understand and hard to predict. Planning is not linear in nature, and its dynamic change can be managed through a homogenised application of the Legal and Administrative processes of any planning institution, backed by a proactive approach to planning control. This approach can materialize through systematic monitoring and evaluation methods that not only control permitted development but also feedback analysed information for the sustainable improvement of the same policy binding document.

1. INTRODUCTION

In the run up to the enactment of the Strategic Plan for Environment and Development (SPED), it was pointed that people are becoming more aware and sensitive about the environment and Government should do all it can to protect it.

This is a very important intimation since it puts the onus on responsible agencies to respond to such calls. It is an indicative signal that society in general wants something to be done as substantiated by a number of leading NGOs. The SPED which will provide the strategic foundation of the 'new' planning system, needs to cater for a more sustainable framework for the regulation of physical development in Malta. It is aimed at pursuing a more 'containment' approach to urban sprawl but still with the main objective of 'Investing in Competitiveness for a Better Quality of Life' (GoM 2015c).

However the bottom line lies in the way this sustainable 'marriage' between protection and competitive investment can actually transfer itself on the ground.

2. MALTA'S PLANNING AGENCY AND SUSTAINABILITY

The current planning system in Malta is run by a national agency which was originally set up following the enactment of the Development Planning Act in 1992. This Act had introduced structure planning with the scope of creating an integrated approach to development, primarily through the enactment of a general policy document (Structure Plan) and a number of specific documents (Local Plans) covering the whole of the Maltese Islands. After 10 years, this agency was merged with the Environment Protection Department (which had been set up under the

Environment Protection Act, 1991) into what was to be called the Malta Environment and Planning Authority (MEPA)1.

Similar to other foreign planning regimes, Malta's planning system is based on the so called planning trinity (Millichap 1995, 2), namely

- *Forward Planning*, which is responsible for the integration of the strategic concepts into plans and policies;
- *Development Control* which oversees and controls physical development as guided by spatial plans and policies; and
- *Enforcement* which has the onus of monitoring and ensuring that what has been lawfully approved on paper will ultimately reflect the aspirations of the Forward Planning concepts.

It is not the first time that these three planning pillars have come under fire, partly for the approval of development permits that appear not to be in line with legally binding policies or for the inability of the Enforcement Directorate to control development as envisaged in the Planning Act itself (NAO 2013)**.** It is inevitable that in a small island state like Malta, there is not much room for mistakes, since the effects of development tend to be permanent in nature. However, planning infringements have always existed in whatever place and time, even in countries with planning traditions that have long been established (Gauci 2015). Admittedly, such anomalies have been and will always be part and parcel of planning. What matters is how planning agencies address these pitfalls which basically have their roots in the procedural application of the day to day running of the overall planning process. The various concerns and issues related to the proper and sustainable control of development planning can be categorized under the following two main processes, namely

3. THE LEGAL AND THE ADMINISTRATIVE

In essence both processes are two faces of the same coin. Their input to the various considerations and implications that arise daily in a planning environment has considerable bearing on planning decisions that will ultimately affect the sustainable issues at play. In other words, these two arms have to find ways and means how to ably support and administer whatever the *planning trinity* throws at them.

In every society, the power to control has to come from legislation, which in itself needs to advice administration towards what is deemed sustainably right in the interest of the public, that is, present and future generations. The provisions of the Environment and Development Planning Act (EDPA), takes this stance into consideration and explicitly speaks of everyone's "duty to protect the environment and to assist in the taking of preventive and remedial measures… in a sustainable manner" (GoM 2010, Part II Sec.3). This declaration imposes a legal responsibility on Malta's planning agency to sustainably administer the 'prevention' and 'remedial' measures of Development Control. The attainment of this legal requirement is no mean feat and it has to start with a homogenous approach to development control by both the Administrative and Legal arms. These two important pillars, in a legally constituted organization, have to combine their resources for a uniform administration of the law, which will lead to accountable, just and enforceable decisions. The answer is not straight forward and society in general needs to understand that 'Planning' in practice is not the solving of a complicated equation, but a complex science that has no straight forward answer. Furthermore, land use planning decisions need to reflect the targeted initiatives of crucial sectors such as Health, Education, Agriculture, Social and Economic. Ultimately, land use or rather spatial planning is the driver that blends all these planning initiatives together, resolving conflicts and promulgating the integrated approach.

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[1] Following a new government in office in 2013, plans are now at an advanced stage to demerge the Planning arm from that of the Environment.

However the initiative has to come from a proactive approach to planning, which has the ability to learn from past mistakes and to prevent, detect and correct unwarranted development from its early stages. And this is where the competence of the Enforcement pillar, to be there **where** and **when** it matters, plays a crucial part. In practice this is no easy feat, but still achievable primarily through an in-built monitoring and evaluating system. This system not only needs to ensure the following of approved plans and conditions of a permitted development but is able to record and provide feedback to the other two planning pillars.

Notably effective monitoring depends on an equally effective monitoring procedure; otherwise this will impinge on the overall planning process. This was highlighted during a recent audit exercise carried out by the National Audit Office on MEPA's Enforcement operations in Outside Development Zones. The exercise noted that detecting of non-conformities with planning and environmental legislation through surveillance monitoring was significantly the lesser extent of methods used by the Enforcement Directorate (Auditor General 2013, 7). Planning and its enforcement costs money both to the developer per se and also to the state in general. For such a reason, prevention is considered as a better cure and the tool to attain this approach is primarily through systematic monitoring.

In a report prepared by the Organisation for Economic Co-Operation and Development (OECD) on better policies for development, it is stated that regulations are indispensable for the proper function of economies and the society they operate within (OECD 2013). Regulations create the rules of the game for citizens, business, government and civil society. Their importance has not been unnoticed and in the last decade OECD countries have been investing time and resources in examining the need for regulation and assessing regulatory options. Moreover, as well as improving the design of new regulation, OECD countries have searched for opportunities to remove unnecessary burdens on the business community and citizens alike (OECD 2013). It is common knowledge that 'regulators' in many countries are being put under increasing pressure to perform, albeit to do more with less. While the demands for better protection of the environment have become, not only more vociferous, but also more stringent, economic crises induce governments to cut down on resources spent on public administration. That is why a well informed and balanced planning strategy can provide the correct incentives that can still attain the goals as set out in the plan.

The subject of sustainability through the combined application of Forward Planning, Development Control and Enforcement cannot be taken lightly. In today's result-based management approach, much success is owed to *quality* and *quantity*. However quality and quantity demand trained resources that are the fruit of applied knowledge and superior methods and techniques, based on modern and sustainable capacity development concepts. The best way to control is to prevent the conditions that instigate bad planning practices. Notably the key to effective control over development is monitoring.

In a small and densely populated country like Malta, the practice of development planning needs to get its sustainable principles spot on. The right balance has to be struck, particularly through a more consistent and streamlined application of approved policies, which also reflect the planning principles at sector level. In conclusion, although the practice of Development Control will never be easy, the perception of modern society needs to accept and react sensibly to the importance of regulation and its changes over time. Alternatively, Planning Authorities have to provide the tools to complement this reaction.

If what we think and plan is not sustainably reflected on the ground, then what is the use of thinking and planning in the first place?

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Europe and the Mediterranean
Towards a Sustainable Built Environment

Chapter 4

Sustainable Strategies for Cultural Heritage

Cultural Heritage Research Trends in Europe

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Abstract. European cultural heritage assets are the important resources that enable future development of society based on their services. They promote economic development of urban and even more, protected rural areas within the Natura 2000 network. Sustainable development of Europe is for decades supported by research funds available through different channels among which are the EU Framework Programs since 1984, COST Actions, EUREKA Projects and Interreg Projects. The current research program continues the well-established tradition of investing in heritage research where both tangible and intangible heritage is considered. Since the regional development of Europe is among the most important drivers of the implementation of united Europe the cultural heritage is its essential part. EU HORIZON 2020 Program is addressing the Societal Challenges among which are the one covering climate action, environment, resource efficiency and raw materials. The cultural heritage research in this Challenge is put in the context of the Nature-based solutions, but it is not the only area in which cultural heritage research finds it place within HORIZON 2020.

Keywords: cultural heritage, Europe, sustainable development, research programmes, HORIZON 2020, research trends

1. INTRODUCTION

A renewed awareness of the value and importance of heritage assets has led to substantial funding for R&D to safeguard our cultural future. It has been reflected in the financing of projects since the first Framework Programme for Research & Technological Development (FP1, 1984-87) and continues into current HORIZON 2020 that follows FP7 (2007-13). In the past 30 years a large community of researchers, experts and specialists have had a chance to learn and develop the transferable knowledge and skills needed to inform stakeholders, scholars and students. Europe has become a leader in heritage preservation science, with COST Actions adding value to projects financed within the FP and EUREKA programme and transferring knowledge to practice and supporting the development of SMEs.

Therefore, it was a logical decision of European Commission to include the cultural heritage research in proposal of HORIZON 2020. Learning from experiences gained within the activities of the European Construction Technology Platform, Focus Area Cultural Heritage (ECTP FACH), the efficient way of engaging as much as possible is established through research that is:

- Mutually supported by the European Commission (EC) and national resources through the Joint Project Initiative (JPI).
- Mutually supported by industry and the EC (like the E2B Energy Efficient Association).
- Entirely supported by the EC.

The third pillar is the most stable one because it does not suffer from the eventual lack of national funds or from the commercial interest of large companies. Only the third pillar entirely ensures independent research, which delivers results without restrictions to the EU community, gives benefit to all interested stakeholders and ensures researchers and experts further engage in heritage safeguarding. In continuation, this paper addresses the cultural heritage research perspectives as included in the HORIZON 2020 documents. The author of paper has been a co-coordinator of ECTP FACH [1](2004 - 2015) and a member of the Horizon 2020 Advisory Group (AG) for Societal Challenge 5: “Climate Action, Environment, Resource Efficiency and Raw Materials” (2013-2015). The group of 31 experts from 17 EU countries has been established by EC to contribute to the implementation of Horizon 2020 providing advice to the Commission services. The advice provided would contribute to a broader policy context: to the Europe 2020 Strategy, the innovation Union, and to other relevant EU policies.

2. FOCUS AREA CULTURAL HERITAGE (ECTP FACH)

Stakeholders in construction sector with support of EC have established the European Construction Technology Platform (ECTP) and its six Focus Areas (http://www.ectp.org) in 2004. One of objectives of ECTP was to help EC in definition of needed research within Framework 7 to contribute to development of construction sector and other economic activities linked to it. From the very beginning, the active role of construction SMEs in preventive conservation of cultural heritage has been recognized and therefore the Focus Area Cultural Heritage as one of six pillars of ECTP has been established. The main aim of FACH is to identify industrial research priorities in built heritage to raise the sector to a higher world-beating level of performance and competiveness. The research challenges related to the involvement of the construction industry in the preservation of cultural heritage are focused at the intersection of technology and environment in order to maintain the rich cultural heritage of the European countries. Socioeconomic impacts are also addressed in order to reach the goals of a consequence-based approach to heritage protection.

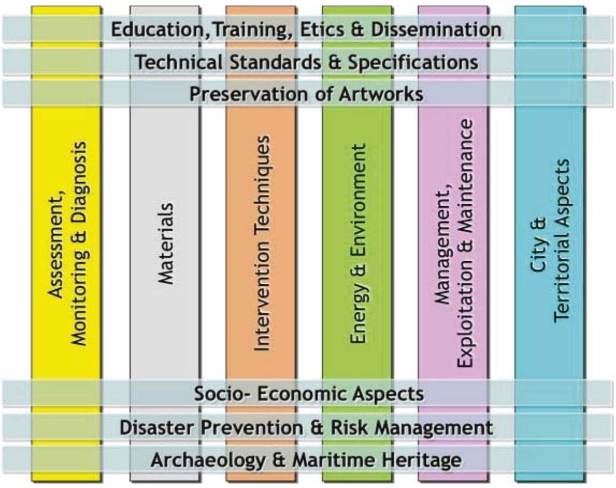

Fig 1: ECTP FACH cultural heritage fields of research

The basic document of ECTP FACH is Vision 2030& Strategic Research Agenda which is regularly updated following the needs and trends in cultural heritage preservation. From the very beginning in 2004 the scheme of research fields of interest has been identified by active FACH members and graphically presented in form of “pillars and belts” as shown in figure 1 above. There are two groups of research interest each linking together three subgroups. The first group covers predominantly preservation of cultural heritage: assessment, monitoring & diagnosis, materials and intervention techniques. The second group is oriented to sustainability aspects of heritage protection: environment & energy, management, exploitation & maintenance and city & territorial aspects.

These main six areas are horizontally linked with another six cross-areas where each of them is partly integrated in main vertical areas. The long-term requirement to develop knowledge and its transfer through education and training at all educational levels is important for exploitation and implementation of research results. Implementation of sustainability in cultural heritage protection, constant vigilance over socio-economic impacts of interventions into cultural heritage and promoting the development of relevant European directives, codes and standards is substantial for long-term preservation of heritage assets. Emergency preparedness in response to natural hazards such as earthquakes, strong winds, fire and floods and the use of human-centered information and communication technologies for raising awareness are important for risk mitigation and increasing of heritage resilience. The knowledge generated from research in this horizontal area is bases for increasing of ability of SMEs to develop skills and techniques. Art works are also to be considered as a valuable and integral part of the immovable heritage as both are affected by the environment and the microclimates fluctuations or by effects of poor daily maintenance of buildings. The area of archaeology and maritime heritage came in focus of FACH in its later phase of development.

3. EU HORIZON 2020

Horizon 2020 is the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment that this money will attract. It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market.

Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. Seen as a means to drive economic growth and create jobs, Horizon 2020 has the political backing of Europe's leaders and the Members of the European Parliament. They agreed that research is an investment in our future and so put it at the heart of the EU's blueprint for smart, sustainable and inclusive growth and jobs.

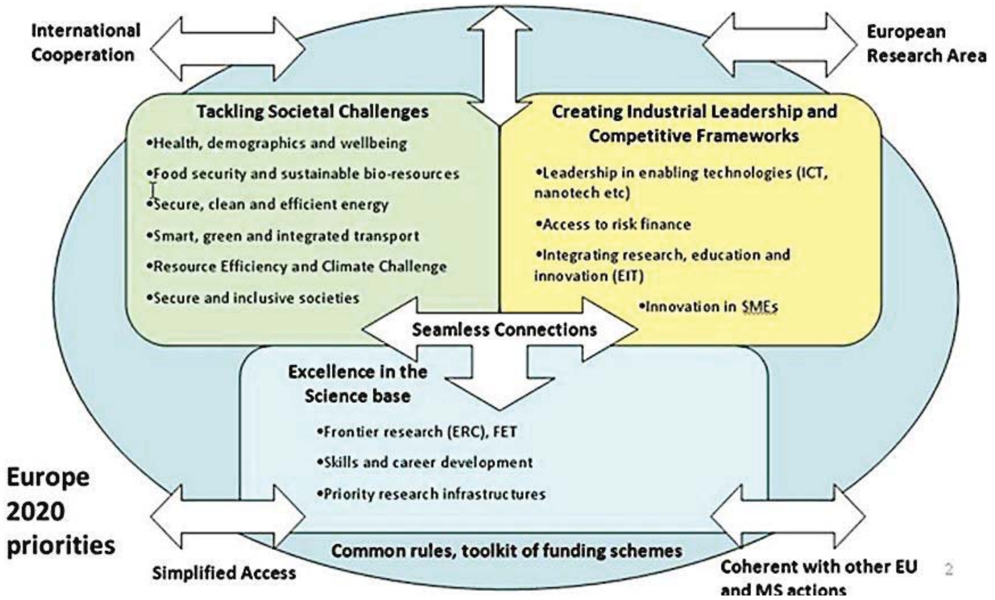

Figure 2: Scheme of the horizon 2020

By coupling research and innovation, Horizon 2020 is helping to achieve this with its emphasis on excellent science, industrial leadership and tackling societal challenges. The goal is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation.

The EU Framework Programme for Research and Innovation will be complemented by further measures to complete and further develop the European Research Area. These measures will aim at breaking down barriers to create a genuine single market for knowledge, research and innovation.

The main priorities of Horizon 2020 are:

- Excellent Science: Strengthening the EU's global position in research and innovation
- Industrial Leadership: Responding to the economic crisis to invest in future jobs and growth
- Societal Challenges: Addressing people's concerns about their livelihoods, safety and environment

The important new feature of Horizon 2020 is coupling research and innovation to establish line from research to retail based on all forms of innovation. It focuses on societal challenges facing EU society: health, clean energy and transport, climate change etc. The crosscutting issues are mainstreamed (e.g. social sciences and humanities, gender, international…).

The work programme preparation is based on guidance obtained from a strategic programing exercise to increase impact of the funding, and a more integrated approach. Work prorammes will be set with a 2 year-duration. Leitmotif of the first two-year (2014-15) work programme was the economic crisis and the path to sustainable growth because Horizon 2020 can make a significant contribution to this effort

The 'Key drivers' that are used to identify areas on which resources and effort will be foused for maximum impact are:

- Sustainable competitiveness, innovation and growth;
- Leveraging engagement of industry, including SMEs;
- Access to finance;
- Developing new knowledge and contributing to skills;
- Deployment of enabling technologies;
- Measures to address the research and innovation divide;
- Supporting strong partnership with Member States;
- Strategic approach to international cooperation

4. CULTURAL HERITAGEIN EU HORIZON 2020

4.1 *The Advisory Group SC5*

Research in the area of cultural heritage is recognized as an important crosscutting issue strongly present in two Societal Challenges. These are Challenge 5: “Climate action, environment, resource efficiency and raw materials” and Challenge 6: “Europe in a changing world - inclusive, innovative and reflective societies”. Activity of Advisory Group for Societal Challenge 5 resulted in several documents. The First Report of the AG was issued on May 2014. Following it Consultation of the HORIZON 2020 Societal Challenge 5 were launched for period of May 14 to June 16, 2014 in order to collect from the stakeholders suggestions concerning potential priorities for EU research and innovation funding in the work programme 2016-2017. Stakeholders responded with 139 contributions. Groups of stakeholders and breakdown of their contributions in % are presented in figure 2 below.

From the diversity of contributions, the clear consensus was about the need to implement systemic and interdisciplinary solution – oriented approaches, with participation and engagement of stakeholders (i.e. academia, industry, financing bodies, local authorities, final users, CSOs, citizens). Further details on the results of the consultation are available in the short analysis of the contributions.

In the first two years of HORIZON 2020 (2014-15) 14 cultural heritage-related calls were launched within Societal Challenges 5 and 6. Activities for issuing f calls in the next 2016 -18 period are underway. Advisory Groups, assisted by the Expert Groups, are developing the strategy for research financing.

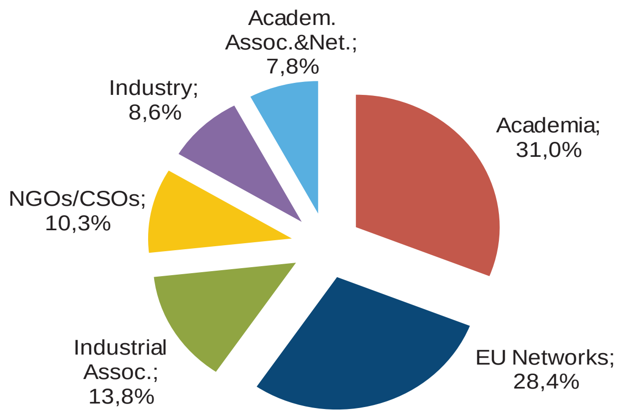

Fig 2: Breakdown of organisational contributors (%) to public consultation on Horizon 2020 SC 5 Strategic Programme

The AG report explored the following four priority areas for SC5 in H2020:

- Systemic eco-innovation
- Climate services
- Nature-based solutions
- Sustainable supply of raw materials.

In addition, a number of important cross-cutting priorities where identified:

- Environment, health and well-being
- Sustainable provision of food and water
- Sector specific challenges – e.g. building industry
- Migration
- Geopolitics of climate change and resources.
- Role and potential of cultural heritage
- Developing Comprehensive and Sustained Global Environmental Observation and Information Systems.

The Advisory Group evaluated the immediacy of each previously indicated priority. The AG concluded that all four-priority areas listed above should be considered in 2016-17. It was also noted that there were links between the priorities, which need to be clearly demonstrated. Moreover, the AG highlighted the importance of integrating priorities across Horizon 2020 (for example, Environment and Health; Climate, Food and Water) and noted that it would welcome the opportunity to progress cross cutting actions and opportunities further.

Advisory Group from the beginning of its activities has recognized the importance of research in cultural heritage. In the AG SG5 Report cultural heritage is included in the priority area of nature-based solutions due to its links to the environment. It is stated: *"Europe is especially rich in assets under this category, which is also an important economic sector through its contributions to tourism and employment that can be implemented in a (generally) low impact environmental way. The sector is, however, under some threat through both social and climatic changes that need to be better understood and addressed. Development of some brownfield sites as centers of our cultural heritage, the reopening and sustainable exploitation of closed sources of traditional materials to supply heritage-compatible repair materials and the revitalization of the vanishing skills and professions needed for qualified intervention in heritage assets are all important potential sources of green growth in the future"*.

4.2 *The report of the Expert Group on Cultural heritage*

Following the activities and conclusions of the Advisory Group SG5 the Horizon 2020 Expert Group on Cultural Heritage has been established in 2014 within the DG Research and Innovation hosted by the Directorate I – Climate Change and Resource Efficiency. The group of ten experts in cultural heritage was chaired by Philippe Busquin, former Member of the European Parliament (2004 to2009) and former Member of the European Commission with responsibility for research (1999 to 2004).The main objective of the Group's work was to provide advice and recommendations to the European Commission, and to help define an innovative EU R&I policy framework and agenda for cultural heritage, that can build on the potential of new business models and social innovation, to stimulate financing in this sector.

The activities of the Group resulted in the report entitled "Getting cultural heritage to work for Europe" published in April 2015. When the report was handed over on June 18 2015 to Carlos Moedas, European Commissioner for Research, Science and Innovation, he said: "*For 2016-17, we want to substantially increase the investment in cultural heritage research and innovation from Horizon 2020, bringing it to more than €100 million. This report will be the basis for a renewed and dynamic framework for EU research and innovation on cultural heritage.".*

4.3 *The highlights of "Getting cultural heritage to work for Europe"*

The rich cultural heritage of Europe makes it the world's number 1 tourist destination and is the third largest socioeconomic activity in the EU contributing 415 billion Euros to the EU GDP and employing 15.2 M citizens where many of those jobs are linked to heritage. Renovation and maintenance represents more than a quarter of the value of Europe's construction industry. The property values of residences in historic districts outperform comparable properties in modern developments. Businesses tend to locate in these areas, as it is easier to attract specialists and expats to live and work in such places. The businesses often seek out historic buildings that can be converted into office space for their headquarters. Cultural heritage enables innovation and enhances the long term competitiveness of the European economy. Recently, the cultural heritage is increasingly regarded as a positive contributor to European GDP. It is now widely appreciated as an essential part of Europe's underlying socioeconomic, cultural and natural capital. This is a significant change in focus as cultural activities have traditionally been regarded as costs to society.

The economic benefits of cultural heritage have most commonly been seen in terms of tourism, but
now it is also seen as an innovative stimulant for growth and employment in a wide range of traditional and new industries. It is also to be recognized as major contributor to social cohesion and engagement as a way of bringing together communities and stimulating young people to engage with their environment. The report of Expert Group set three objectives:

- Economy: Promoting innovative finance, investment, governance, management and business models to increase the effectiveness of cultural heritage as an economic production factor
- Society: Promoting the innovative use of cultural heritage to encourage integration, inclusiveness, cohesion and participation.
- Environment: Promoting innovative and sustainable use of cultural heritage to enable it to realize its full potential in contributing to the sustainable development of European landscapes and environments.

The traditional model of cultural heritage societal role is incomplete in a period when the public sector does not have adequate funds to maintain its assets. Private sector primarily invests in tourism services and products delivered by hotels, restaurants and shops while the public sector focuses on historic buildings, parks and museums

The alternative approach is based on larger involvement of private sector in cultural heritage, in order to optimize its use within its own business model. This would build on the potential of historic areas as well as intangible assets to nurture new manufacturing, service and creative industries attracting investment in the fabric of heritage as well as creating growth and jobs. The major instruments of involvement are tax breaks, differentiated VAT rates, well designed grant or loan programmes, public private partnerships (PPP) schemes, rights release etc. that are expected to encourage the private sector to invest in cultural heritage.

Demonstration projects could show communities, cities and regions how their cultural heritage can be used to create employment in construction-related industries, cultural and creative industries and digital and clean technologies Private investment restores and adapts heritage assets, delivering cultural and environmental services in historic areas.

At a time when deregulation and decentralization are policy goals in nearly all European countries, there are strong arguments for new collective arrangements for heritage and landscape management. These are reinforced by reductions in central budgets for protection and management of heritage, and the limited capacity of the commercial market to take up the slack. An innovative use of cultural heritage has the potential to actively engage people - thereby helping to secure integration, inclusiveness, social cohesion and sound investment, all necessary ingredients of smart, sustainable and inclusive growth.

The digitization of cultural heritage, whilst initially framed by institutions, is now increasingly a collective process involving community access and collective sharing of knowledge. Citizens' engagement in cultural heritage management and preservation could be further investigated in order to build on the emerging practice through new investment and the use of digital technologies. For an aging population with more leisure time, cultural heritage offers a major opportunity to engage older citizens; engaged and motivated citizens stay healthier.

Cultural institutions can contribute to involving youngsters and unemployed people in cultural heritage related activities (e.g. renovation projects, museums, community management) in order to develop their self-confidence and professional skills and enable them to return to the job market even in sectors not related to cultural heritage.

Cultural heritage plays an important role in the sustainable development of rural and urban cultural landscapes. These very rarely consist exclusively of natural ecosystems. Instead, they are made up of a broad range of semi-natural or cultural ecosystems whose diversity has been determined to a large extent by the past management of humans. As a result, many natural and semi-natural landscapes are teeming with all kinds of cultural heritage, including archaeological relics, historical landscape features, architecture as well as more intangible values such as traditions, stories and homonyms.

It is widely recognized that is a need for development of new tools, methods and approaches for planning and managing these complex dynamic systems with covering of a broad perspective of cultural heritage.One of the major challenges in European heritage management for the next few years is the development of new heritage commons. Stronger engagement and involvement of local communities in landscape and heritage management, new sources of financing as well as a considerable reduction of management costs could be a possible impact.

Having in mind the above discussed objectives, the Expert Group proposed several actions:

- Urban rehabilitation and heritage led urban regeneration
- Sustainable tourism
- Integral landscape management
- Vocational qualifications for young people regarding built heritage
- Raising awareness and facilitating cultural participation
- Addressing youth unemployment and disengagement
- Adaptive re-use of the industrial building complex
- A crowd funding platform for cultural heritage
- Post-Restoration of intangible heritage

The following titles illustrate recent and near future calls for projects:

- Virtual museums and social platform on European digital heritage, memory, identity and cultural interaction. (CULT-COOP-08-2016); deadline was February 4 2016.
- Cultural heritage as a driver for sustainable growth (SC5-21-2016-2017), 1st stage deadline was March 8 2016 and 2nd stage deadline is September 6 2016.
- Cultural heritage of European coastal and maritime regions (CULT-COOP-07-2017), deadline is February 2 2017.
- Innovative financing, business and governance models for adaptive re-use of cultural heritage (SC5-22-2017), deadline is March 7 2017.

5. CONCLUSIONS

Cultural heritage is increasingly regarded as a positive contributor to European GDP. Therefore, it is widely appreciated as an essential part of Europe's underlying socioeconomic, cultural and natural capital. This is a significant change in focus as cultural activities have traditionally been regarded as costs to society. The availability of cultural heritage and services enriches the quality of life for European citizens and contributes to their wellbeing, sense of history, identity and belonging. Such social benefits are beyond what can be measured in terms of pure income statistics and have been long recognized. As early as the 14th century, the Statutes of independent Italian municipal cities attributed to cultural heritage foreign visitors' happiness and residents' honor and prosperity, based on beauty, embellishment (decorum), dignity, public pride and public good (publica utilitas).Europe's intangible cultural heritage – films, theatre, music and dance as well as craftsmanship and cuisine – are important reasons either for tourism inflows or for exports of services, manufactured goods and produce. Combining the attractiveness of intangible heritage and presenting and utilizing it within the built heritage spaces using contemporary tools of ICT technologies brings the new life to heritage assets enabling their economic effectiveness. The European Commission that recently foster the investment in cultural heritage research and innovation from Horizon 2020 strongly contribute to the role of cultural heritage in further development of European economic growth.

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Towards Sustainable Access, Enjoyment and Understanding of Cultural Heritage and Historic Settings

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Abstract. ICT can further and encourage an inclusive approach to Cultural Heritage improving interoperable systems and tools able to enrich the interdisciplinary knowledge of European cultural identity by a wide range of users (tourists, students, scholars, researchers, technicians). New technologies and digitization processes play a key role since they allow new and enhanced interpretations of our collective cultural heritage, while contributing to preservation and safeguard strategies based on sustainable approaches in the intervention for improving accessibility and understanding of cultural heritage and historic settings. The paper includes a presentation of the European Project "INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic model", funded by EC within the Programme Horizon 2020: a project focused on innovative methodologies for creating 3D models with an inclusive, interdisciplinary and sustainable approach to enrich the knowledge of European Cultural Heritage and its different identities.

1. INTRODUCTION

Cultural heritage is a driver of societal cohesion and identity. Europe's cultural heritage is the expression of the great diversity and different cultural identities that constitute and characterize our common cultural legacy. Although the richness of cultural heritage at European level is a great resource for social, cultural, creative and economic growth, it is subject to risk of loss because of deteriorations, insufficient maintenance, exposure to human activities and natural calamities.

The enhancement and the spread of an understanding of Europe's intellectual basis, its history and the internal and external influences, as an inspiration for our lives today, is one of the main challenges that Europe has to face. Improving the understanding of its own cultural heritage and identities can be an important factor to strengthen cohesion and solidarity and to encourage modern visions and uses of its past.

New and innovative solutions, methodologies and technologies are needed for the knowledge, preservation and management of tangible cultural heritage in Europe, as well as to promote the widest possible dissemination.

Information and Communication Technologies are constantly evolving and new digital media are increasingly used for accessing and understanding and preserve cultural heritage; they allow new experiences and enjoyment of cultural sites giving the opportunity to approach more easily something that very often is perceived as distant and unattractive.

Multimedia interactive guides realized in 3D for museums, exhibitions and archaeological sites, smartphone applications, touchscreens, multimedia books with dynamic images and virtual reality, are just some examples of new possibilities to learn, understand and access cultural heritage.

Digital technologies, new media and ICT can exploit and maximise the value of tangible and intangible heritage, and are an essential device to explore European cultural diversity and identity.

Communication by means of digital technologies is a way to enhance and promote cultural heritage encouraging a greater flow of economic resources as well as opportunities for create new jobs and professionalism.

2. NEW TECHNOLOGIES FOR A SUSTAINABLE ACCESS, ENJOYMENT AND UNDERSTANDING OF CULTURAL HERITAGE

Digital technologies give the opportunity to improve and expand the comprehension of cultural heritage assets by means of different applications and devices.

Nowadays it is possible to integrate different information in order to access cultural assets in many different ways and for many different purposes, thanks to new languages of interactive media aimed at innovative ways of communication.

Beyond the application of ICT for management, research, education, diagnosis, conservation and restoration procedures, new technologies allow the communication and dissemination of cultural assets, that become more and more accessible for new knowledge and experiences.

Digital technologies allow the off-site visualisation, consultation and study of 3D digital models giving to broad categories of users an easier access to European tangible and intangible cultural assets.

New applications allow to access sites and objects from labs, museums, classrooms, or even staying at home. Users have more and more interactive possibilities to access at a multidisciplinary level information and data from different sites and objects and to enrich and share the knowledge with their findings and complementary insights by means of interoperable platforms and social media.

The development of data capturing technologies and graphic features has maximized the enhancement of digital contents for virtual tour applications, serious games and many different immersive and interactive experiences that enable a sustainable access and enjoinment of heritage sites also by young generations.

Interactive multimedia applications are freely accessible on the web from all over the world, and new mobile devices amplify the possible use of cultural contents. Virtual reconstruction and 3D graphics for cultural communication and entertainment, virtual exhibitions, “iper-museums” with interactive applications and animations, are able to display heritage contents to a broad public. Three-dimensional geometries and scenarios allow to move in different contexts, existing or disappeared.

Enriching semantically the 3D models and improving the applications of Virtual and Augmented Reality, the understanding of the European cultural heritage will be more accurate and will go beyond the virtual tours; these tools will allow everyone to add rich diversity of contexts and interpretations to the 3D models through interactive, story-telling and wiki-oriented approaches using mobile devices.

The present challenge is to increase the digitization of heritage contents (material and immaterial) not only for documentation, management and conservation purposes but also in order to expand the access, use and re-use of cultural heritage by means of digital representations, platforms, devices, social media and ICT tools.

The development of the digitalization tools and procedures will be the trigger for the creation of a “CH Database Repository”, where the 3D models will be collected and shared; evolution of GIS into HGIS (Historical Geographic Information System) will allow to store the geographic coordinates and to display the models into specific historical maps.

3. ICT FOR A SUSTAINABLE SAFEGUARD, MONITORING AND MAINTENANCE OF CULTURAL HERITAGE

Providing information at different levels and trough multipurpose systems, tools and devices, ICTs can improve and enhance accessibility and understanding of Cultural Heritage and make possible a more effective safeguard, monitoring and maintenance.

Nowadays we risk to lose a huge part of the architectural and archaeological cultural heritage faster than it can be documented. Due to the human disaster and inappropriate conservation, very often more than the natural calamities, this heritage is vanishing.

Despite the efforts for preserving monuments, buildings and artefacts, and protecting the archaeological sites, it is not possible to save everything.

"Heritage information should be not only an integral part of every conservation project but also an activity that continues long after the intervention is completed. It is the basis for the monitoring, management, and routine maintenance of a site and provides a way to transmit knowledge about heritage places to future generations."[Latellier et al. 2007]

Research in this field has the ambition to strongly support the development of a pan-European approach to data usage for taking better decisions related to preventive interventions and for supporting of site management and sustainable exploitation of assets.

Innovation and development of digital tools and technologies can play a strategic role, being an effective and now not expensive support for recording, documenting, and managing the information of cultural heritage.

Researchers are currently working on the development of new methods for condition assessment survey based on predictive analysis (diagnostic, conservative, morphometric) and non-destructive procedures (thermal imaging, level of reflectivity, integrated sensors, spectrophotometry, sonic surveys, etc.) supported by economically sustainable technologies and devices.

Technologies and procedures for data capturing, processing and deploying are growing up very fast: the exploitation (geometry, metadata, semantic enrichment) and optimisation of 3D data acquisition tools and the Building Information Modelling (BIM), enriched by semantic information specifically focused on Heritage (H-BIM), are improving and being suitable for new practical purposes.

The 3D modelling, in particular, is one of the main fields of innovation of ICT for Cultural Heritage; challenges to be faced by the innovation process include:

- a significant enhancement of functionalities, capabilities and cost-effectiveness of instruments and deployment procedures for data acquisition and processing;
- the accuracy and efficiency of 3D capturing (by integrating Geospatial Information, Global and Indoor Positioning Systems - GIS, GPS, IPS);
- the development and improvement of hardware interfaces as well as software algorithms;
- methods and tools for making the 3D models easily accessible for all user groups, and interoperable for use by different hardware and software;
- the implementation of open-standard platforms hosting user-friendly Virtual and Augmented Reality operable on mobile devices.

3.1. *3D digital models in representation of heritage*

Application of the 3D digital models in representation and analysis of heritage is growing up rapidly, supporting and making more effective the collaboration across different disciplines.

It is necessary to break through the barriers caused by segmentation in collecting documentation data by establishing a ‘common framework’ for the interpretation of European cultural identity and diversity through 3D documentation of cultural heritage sites and buildings.

Current best practice guidance for the long term preservation of 3D laser scan data is found to be onerous by data creators. Nowadays researchers, scholars, professionals, collections managers, vendors and providers of 3D data capturing and modelling instruments and tools are seeking a new methodology/process in documentation, digital preservation and heritage management, with an emphasis on storing, reusing and archiving the data from scanners [M. Balzani et al. 2009].

A crucial target is the definition of an European common methodology and the implementation of ”standard” tools which allow users to share digital information in Cultural Heritage field.

3.2. *Capturing devices and sources of measurement data*

The assessment and optimization of 3D data acquisition tools are expected to overcome the current limitations of 3D capturing technologies.

Achievement of this target depends on the technical advancement of 3D data acquisition and the development of procedural standards. The best results weighing budget, precision and execution times, combining technologies and techniques, could be facilitated by:

- the development of a concept for an enhanced 3D data capturing system, laser and photo integrated, equipped with a new firmware optimized for cultural heritage application, addressed to an easier and more accessible data processing and modelling;
- the implementations of tools for 3D automatic delineation depending on acquisition technologies, from point clouds to photo-based data, in order to achieve a common standard interoperable output for BIM environment.

Photo-based 3D scanning brings the accurate measurement procedures from the photogrammetrists, and the advanced matching algorithm techniques from computer vision [El-Hakim et al. 2005; Remondino et al. 2009].

3.3. *Tools for automated 3D modelling and analysis*

New procedures and tools for automated 3D modelling and analysis beyond simple digital reconstruction are growing up.

Innovation is going towards new targets as well as:

- the development of digital technologies to enable the automation of the acquisition and treatment of large amounts of 3D data;
- the improvement of tools for 3D automatic delineation and the implementations of tailored algorithm for managing the reflectivity index provided by laser scanning devices;
- the improvement of compatibility of these tools with CAD and BIM software packages, which are the most widespread standards in architectonic delineation.

As part of 3D integrated survey applied to Cultural Heritage, the digital representation is gradually emerging as effective support of a lot of data (images, photos, texts, video, non-destructive diagnostic analysis, multi-resolution images, historical data, etc.) in addition to the shape, morphology and dimensional data.

Research – including the activity within the European Committee for Standardization (CEN) – is working on interoperable standard formats for semantic-aware 3D information, for increasing access to geospatial data and services, computer-aided design applications and building information modelling software. This standardisation activity can help heritage professionals in their conservation and restoration work, allowing experts to exchange information on test and analysis and harmonising and unifying methodologies in the EU.

3.4. *Building Information Modelling (BIM) for Cultural Heritage*

The usual approach in a heritage BIM, after the collection of 3D point clouds, is to locate/define 2D or 3D primitive shapes onto the point cloud.

The next challenge is an improvement of this methodology that can make possible to recognize, into a 3D point clouds, elements, objects and spaces defined by geometrical and morphological information and organized by spatial relationships and architectural styles; the target is to represent architectural elements in libraries as parametric objects and to map them onto point cloud or image-based surveys [Dekeyser et al. 2003].

At the moment, a shared library for historical elements does not exist. Starting from the so called H-BIM approach (Heritage Building Information Modelling), the necessity of the libraries' implementation could be satisfied through the development of methodologies and algorithms for using data survey, especially point clouds, and to model in BIM software [Chevrier et al. 2010, Dore et al. 2013], avoiding the oversimplification of the shapes.

When used in models of cultural heritage, semantic BIM will be able to be connected to different users (e.g. scholars, technicians, citizens, governments) in support of the user's need for interpretation of the cultural heritage model in addition to the common BIM features of 3D visualization, technical specification and dataset.

3.5. *Virtual Reality (VR) and Augmented Reality (AR)*

Interactions between capturing processes and devices, 3D digital modellingpackages and BIM are enhancing the growth and improvement of Virtual Reality (VR) and Augmented Reality (AR) technologies.

VR and AR applications to support the experiencing of Cultural Heritage by a larger public – as well as the serious games designed for educational purposes–are now recognised and well-accepted among scientific community.

Furthermore VR and AR applications are becoming increasingly important in the preservation, protection, and collection of our cultural and natural history; making easier the access to monuments, artefacts, building and culture, these technologies are actually enhancing the learning process, motivating and understanding of certain events and historical elements for the use of students and researchers.[Noh et al. 2009].

Some of the relevant contributions that can be made by VR and AR technologies include:

- creating educational resources for history and culture reproducing in a virtual way historic monuments and sites that no longer or only partially exist;
- a reliable documentation for repairing or reconstructing historic buildings in case of damages due to disasters;
- visualizing and visiting places and sites impossible to be accessed in the real word;
- giving the people the possibility of interacting with spaces and objects without risk of damage improving the quality of virtual tourism and virtual museum exhibitions.

4. HOW THE ICT TOOLS CAN GIVE AN ACTUAL CONTRIBUTION TO ENHANCE THE UNDERSTANDING OF CULTURAL HERITAGE

The contribution of ICT tools to the enhancement of the understanding of Cultural Heritage can be relevant and depends on their accessibility for all types of user.

The tools have to be suitable for multiple purposes depending on the needs and level of knowledge of the end-users.

The 3D semantic models, for example, can be used in different ways and by different types of users thanks to their multipurpose structure and data that include: geometric information for 3D visualisation, historical information for narration and geo-technical, as well as structural information for material conservation, maintenance and refurbishment.

Innovation and development of ICT tools for Cultural Heritage can contribute, in particular, to the development of: an inclusive understanding of European cultural identity, a financially sustainable safeguard of the cultural assets and an effective network for sharing data, information and knowledge.

4.1. *Creation of an inclusive understanding of European cultural identity*

Implementation and strengthening of an inclusive understanding of European cultural identity and diversity is possible stimulating and facilitating collaborations across disciplines, technologies and sectors.

These aims can be reached by:

- *enabling 3D digital reconstructions in an open-standard format for Heritage Building* Information Model (H-BIM); such models can be easily accessible and reusable by researchers, scientists, experts and creative practitioners working in cultural and heritage industries in order to promote collaboration across sectors and facilitate cross-disciplinary researches, dissemination, education and business opportunities;
- asemantic integration of rich narratives with Virtual and Augmented Reality (VR/AR) to create accurate perception and deep understanding for specialists and common users; the accessibility and analytical quality of the models can be supported by Semantic Web platform with Semantic Query function to retrieve rich data, as well as to interface between hardware and software for VR and AR;
- developing user apps for mobile devices to access and enrich the H-BIM; apps can be designed for specialists as well as common users to access the socio-economic significance for diffusion, dissemination, knowledge and enhancement of Cultural Heritage.

4.2. *Development of cost-effective procedures and tools for on-site survey and reconstruction of cultural heritage artefacts, buildings, sites and social environments*

This is a crucial target for making feasible and sustainable an effective policy of safeguard of the cultural assets. It can be achieved by:

- a substantial enhancement of the efficiency of three-dimensional data capturing procedures and devices, especially improving their suitability and aptitude for the physical cultural resources and assets: cultural heritage sites, historical architectures, archaeological sites and artefacts that are characterized by smart handling of non-conventional characteristics, location and geometries;
- developing new methods for condition assessment survey of cultural heritage which are based on predictive analysis (diagnostic, conservative, morphometric), non-destructive procedures (thermal imaging, level of reflectivity, integrated sensors, spectrophotometry, sonic surveys, etc.) and will be supported by economically sustainable technologies and devices;
- an essential optimisation of hardware and software instruments for easy scan system, rapid capture of main features/geometric data and automated data output in an H-BIM environment.

4.3. *Development of open platforms for accessing, processing and sharing results and data from surveys*

This objective can be achieved by:

- the development of standards for managing 3D data at multiple scales: from artefacts and buildings to environment and infrastructure, linked with GIS (Geo-spatial Information Systems);
- the definition of open-standard formats and semantic ontologies to generate high-quality, reliable and interoperable H-BIM;

- the implementation of Application Programming Interfaces to allow both definition, implementation and interoperability of various software and data models without compromising quality and functionality;
- the implementation of multilevel database of 3D semantic models oriented towards various use cases, such as: understanding, enhancement, promotion, management, and enjoyment of cultural heritage and supporting conservation and restoration works.

5. THE INCEPTION PROJECT

In the 2015 the project “INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic model”, applied for the Work Programme *Europe in a changing world – inclusive, innovative and reflective Societies* (Horizon 2020 – “Reflective Societies: Cultural Heritage and European Identities”) has been selected to be funded by the European Commission. The project has been proposed by a consortium of fourteen partners from ten European countries led by the Department of Architecture of the University of Ferrara (scientific coordinator Prof. Roberto Di Giulio).

Among the main results that project aims to reach: the innovation of technologies for creating 3D models with an inclusive approach to Cultural Heritage; the implementation of models able to enrich the interdisciplinary knowledge of European cultural identity by scholars, researchers and non-expert; the development of an open standard platform to “contain”, implement and share the digital models.

The research team includes in a broad way the different aspects of identity and diversity of cultural heritage putting into effect one of the main challenges that the European Commission has launched by the program Horizon 2020 and in particular in the Societal Challenge 6: to contribute to a deeper awareness and understanding of European cultural heritage as inspiration for addressing contemporary challenges, increasing the knowledge of heritage and its different identities.

To this purpose, new technologies and digitization processes play a key role since they allow new and enhanced interpretations of our collective cultural heritage, while contributing to sustainable economic growth.

Within interdisciplinary consortium the balance between research and business ranges in different specific fields of interest of Cultural Heritage including:

- the documentation and diagnostic strategies for heritage protection, management and enhancement;
- the 3D acquisition technologies and a wider and more extensive use of digital models;
- the development of hardware, software and digital platforms aimed at representation and dissemination of cultural heritage through ICT processes;
- the market research and business strategies for the economic value of cultural heritage, a sector struggling because of the financial crisis.

The project will implement six demonstration cases starting with the recognition of the specific needs and requirements of each building or cultural site, enabling the implementation of several digital acquisition systems and developing specific three-dimensional modelling operations that will make the digital models used by different categories of inter-disciplinary users, populating the INCEPTION platform.

The project aims to strengthen innovation in 3D modelling of cultural heritage through an inclusive approach for time-dynamic 3D reconstruction of artefacts, built and social environments.

The main objectives are:

- the creation of an inclusive understanding of European cultural identity and diversity by stimulating and facilitating collaborations across disciplines, technologies and sectors;
- the implementation of cost-effective procedures and enhancements for on-site 3D survey and reconstruction of cultural heritage artefacts, buildings, sites and social environments;
- the development of an open-standard Semantic Web platform for accessing, processing and sharing interoperable digital models resulting from 3D survey and data capturing.

Starting from the mapping of knowledge demands and users’ key requirements, the project aims to develop a substantial advancement in hardware and software through the enhancement of 3D data capturing and processing and the optimization of the BIM-oriented data conversion; it is expected to make easier the collection of the3D models in a BIM-based platform managed by a semantic web ontology and inclusive web interface. Innovative strategies for models deployment and user-oriented applications will be the last step of the project.

The interdisciplinary approach will be developed by means of:

- the creation of a common framework for cataloguing methodology;
- an actual advancement in integrated data capturing processes;
- the implementation of a semantic modelling for Cultural Heritage buildings;
- the development of the INCEPTION platform;

The INCEPTION project aims at an effective knowledge and dissemination of European cultural heritage through a Stakeholder Panel, an assembly of European institutions,already involved during the project preparation phase, which will provide a meaningful panel discussion with experts in the field of Cultural Heritage. It will direct the research toward those strategies needed by "end users" and institutions to increase knowledge, enhancement and dissemination through digital models in order to promote the inclusiveness and accessibility of European cultural heritage.

The project places great importance in the role of the Stakeholder Panel, both in the scientific debate on the interdisciplinary themes and in the active role of dissemination and effective use of research results.

The institutions involved in the project "demonstration cases" will cooperate in the development of important applications, tools and methodological processes of great value and interest. The strategies of dissemination of digital models will involve both in situ applications for visitors, tourists, scholars and researchers, and remote applications that enable the widest possible access and knowledge of cultural heritage.

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The holistic e-Documentation of the Past: Risks and Challenges

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Growing modern globalization, rapid social change, wars and economic crises cause mass people movement and uprooting, threatening the local/national character of our culture. Indeed during the 20th century (e.g., the WW I/II), it is considered that nearly 50% of Europe‘s Cultural Heritage (CH) was lost. In addition, much of our cultural heritage is under attack from environmental degradation and climate change, from socio-economic pressures and the accelerating pace of urbanization, from the strains of global tourism and from forgery or trade in stolen artworks and last but not least from the mere passage of time itself. Examples include (i) looting (illicit trafficking in art is a multibillion dollar industry, the USA Justice department www.justice.gov/), (ii) Mankind destructions (war, fire, globalization, tourism, industrial revolution) and (iii) environmental factors (earthquakes, tsunamis, temperature increase, humidity).

According to the 1989 UNESCO recommendation, the 2003 Convention on Safeguarding of Cultural Heritage (CH) and the Treaty of the EU, the preservation of CH diversity and identity is a key issue for the next generations to come.

It is evident, that through the support of ICT, availability of cultural content in digitized forms is a critical necessity for the preservation of the continuity of our heritage and identity. These challenges demand for collaboration amongst all of us: the heritage managers and urban and regional planners, the tourism and construction sectors, policy-makers and civil society groups and, above all, cooperation among conservators, industry, researchers and academia.

Different initiatives currently exist worldwide for the e-documentation and e-preservation of CH, such as Google, the EU Digital Library European, the Library of Congress, the Internet Archive, and the UNESCO Memory of the World Library. As a result, the demands of – the handling and re-use of tangible and intangible e-CH records are increasing more and more-like library, archive, museum objects/artefacts, monuments, folklore and handicraft,-all pose quite different challenges (for example new standards), which on the one hand make the exchange of data between the digital libraries almost impossible, but on the other hand provide new, exciting and innovative opportunities.

At the same time, given that the availability and affordability of tools and algorithms to support digitization of cultural objects and artefacts keeps improving, the end-user requirements also keep transforming, and more demanding use or cases keep emerging. Professionals and organizations are now in need of more versatile functionalities, offering not only access and retrieval of such high quality e-CH content but also supporting more sophisticated functionalities such as interoperable cultural object descriptions(metadata), immersion of content into diverse contexts(for educational / cultural / research/ tourism/ 3G-4G smart devices), and 3D reconstruction of –partially- damaged artefacts and monuments.

The aim of this Keynote is to demonstrate the current Risks in CHto present the Challenges for the e-documentation and e-preservation of CHand focus on future European and worldwide research activities in this particular area of interest.

Hong Kong's Campaign for Sustainable Built Environment - Revitalisation of Old Industrial Buildings

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As a manufacturing economy, Hong Kong built in the sixties and seventies a large number of factory buildings to house its industry. Most of these buildings are high rise, flatted, and in multiple ownership. Since the opening up of the economy in mainland China, most if not all of these Hong Kong factories have moved to the mainland in the eighties, many close to Hong Kong in Guangdong and the coastal provinces. As a result, many factory buildings have become vacant or some serve as the head offices of the factories in the mainland. Meanwhile, the Hong Kong economy has gradually move from manufacturing to financial and logistics. The challenge is what to do with these partly vacant old factories. Some have gone into neglect and dilapidation, affecting not only the building conditions, but also the urban districts in which the factories are located. Therefore, the choice is between demolition and re-development or re-vitalisation and reuse. The report will discuss the issues involved in making choice, the challenges and opportunities. What role sustainability and the economics have played in the process? Has the green movement driven the revitalization or is the change in the economy responsible for the future of these old buildings? What part has the Hong Kong Government play in the process? The report will also illustrate how some factory buildings have been transformed, and received a rating under the Hong Kong BEAM Plus green building rating system. In the meantime, the Hong Kong Green Building Council is reviewing its rating system to facilitate the change.

Roadmap for IT Research on a Heritage-BIM Inter-operable Platform within INCEPTION

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Abstract. Within the EU research project titled INCEPTION, a Heritage-BIM Interoperable Platform will be developed and used to store all cultural heritage-related data. This platform will strongly depend on Semantic Web and Building Information Modelling (BIM) technologies that drive the 'INCEPTION Time Machine' where a time dimension will show how the cultural heritage evolves in association with its built and social environments. This paper describes the technical research challenges associated with this platform. An initial research activity is dedicated to review the state-of-the-art in BIM, H-BIM, H-GIS, as well as the utilization of Semantic Web for enabling semantic search and enrichment of Cultural Heritage information by the end-users. The subsequent research activity will focus on the integration of 3D point-clouds and sensor data with the H-BIM. Various data will be stored on the H-BIM platform and made available via APIs and web interfaces. The platform itself will contain services for geometric shape recognition and semantic query. Finally, the AR and VR applications as well as semantic searches, the Time Machine / 4D Viewer component, and a semantic enrichment application will be made available for the end-users and third-party developers alike.

1. INTRODUCTION

The documentation of cultural assets is inherently a multimedia process, addressed through digital representation of the shape, appearance and conservation condition of the heritage architectures and sites. Digital models are expected to become the representation (forever, for everybody, from everywhere) and research needs to acknowledge the changing role that reconstruction, preservation and conservation now play in the representation of heritage and its analysis.

Innovative technologies for creating 3D models with an inclusive approach to Cultural Heritage; the possibility to achieve interoperable models able to enrich the interdisciplinary knowledge of European cultural identity; the development of an open standard platform to “contain”, implement and share the digital models are among the main innovations proposed by the INCEPTION project, funded by the European Commission within the Work Programme *Europe in a changing world – inclusive, innovative and reflective Societies*.

INCEPTION methods and tools will result in 3D models that are easily accessible for a wide range of users, and interoperable for use by different hardware and software. It develops an open-standard Semantic Web platform for: Building Information Models for Cultural Heritage (H-BIM) to be implemented in user-friendly Augmented Reality (VR and AR) operable on mobile devices.

2. STATE-OF-THE-ART

The INCEPTION project will start from the current state-of-the-art developments in the area of BIM and semantic modeling in the context of Heritage BIM, knowledge management, Cultural Heritage asset management software and 3D data capturing.

2.1. BIM semantic modelling in the context of Heritage BIM

A BIM open standard is required to allow managing 3D models supporting the storing of cultural heritage information. Recent scientific and technical works clearly show this demand by means of a cross-disciplinary approach to enhance the analysis and understanding of heritage sites.

This goal is based on the following challenges to achieve an inclusive 3D virtual cultural heritage (Fig.1):

- In practice, is not solved how to handle the large amount of data provided by 2D/3D acquisition devices, or how to extract all possible information from them.
- It is not solved, but demanded, the combination of different information to achieve a useful multipurpose and multiuser 3D model as unique digital representation comprising graphic & semantic information.
- The process involving the generation and management of digital representations is not so usual as expected. Even less involving physical and functional characteristics of heritage according to BIM. These aspects are necessary for the proper standardization of processes, ensuring interoperability and interdisciplinary.

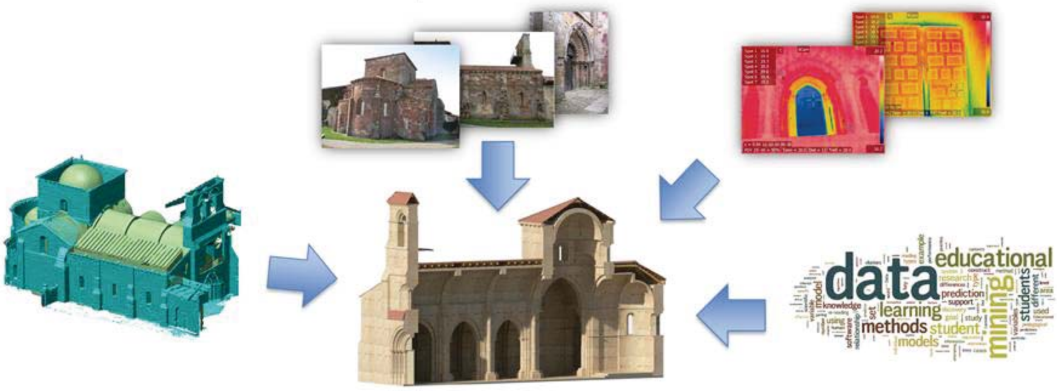


Fig 1: Inclusive 3D virtual cultural heritage approach

Three IT research needs should be addressed on this regard:

- An integrated software for documenting, planning, tracking of interventions and managing of heritage immovable assets (local or remotely) needs to be developed. The software should simultaneously incorporate graphics (plans/layouts, high-res photographs, blueprints, thermal images, etc) and semantic information (meaningful data related to structures, finishes, installations, remote monitoring, historical data, relational databases, textual information, etc). Hence, a well-defined specification on the type of graphical and semantic information required is the first challenge to tackle, taking into account: utility; type (2D/3D); formats; supplier; acquisition technologies; acquisition and processing techniques; directives and references to be applied; usability (citizen, technician, scholars or literature).
- A specific hierarchical organization of European cultural heritage information about buildings based on sematic approach needs to be developed as well. It is a different approach from the geometric information: adding attributes like architectural style, time frame, author and location, or related to physical structure but knowledge cannot be assumed by the geometric data.
- Combining content information on heritage buildings with data derived from the use of survey technologies (i.e. laser-scanner point clouds, photo-based scanning, and monitoring data) into a 3D model is obliged. Specific tools (shape recognition and photographic and thermal image blending) should be developed to allow obtaining BIM-compatible useful information from initially non-parametric 3D models.

The resulting models require to be manipulated into BIM packages (H-BIM) and also to be uploaded onto Internet in order to be handled in mobile devices to ensure maximum usability.

2.2. Knowledge Modelling

The in Knowledge modeling plays a key role in built heritage field due to incremental learning and different user involvement segmentation and scope. Different actors need a different range of information related to the model to enhance knowledge and interact with the physical representation of the building. In cultural heritage cross domain data are available to guarantee a deep understanding of the building history, useful also for maintenance and exploitation.

Knowledge layering starts from the physical description of geometrical entity (e.g. Cylinder cv Column) and refines the understanding of the model with every kind of content that is somehow related to it, like documents, surroundings, historical data and structured representation. Even on modern construction industry narrowing building reconstruction to geometrical modeling is limiting and new libraries have been developed to add additional data for semantic representation of intangible relations.

On historical buildings the very definition of the cultural heritage asset requires that knowledge layers and evolves in time. In this case the lack of documentation linked to the model could be the cause of the loss of part of the research data or restoration issues or even irreparable damages. With the rise of virtual museum and augmented reality citizen and tourists also need to easily find interesting information in digitally represented model, with a knowledge driven approach that requires that data are accessible also by semantic information retrieval techniques.

Interesting attempts to build a semantic knowledge associated to historical building has been made and there are some successful projects which allow the exploitment of historical linked data. Different approaches have been selected due to the focus on different information and the variety of users. One main focus of those projects is how to solve the link between intangible and tangible data context by the integration of a BIM environment with an ontology based system. The W3C standards ontologies already recognized as global reference with a coherent and interesting approach to cultural heritage sharing has been analyzed with a focus on conversion and references between geometrical data, time representation, ontology based knowledge and general textual documentation.

Then standardized ontologies and formalized system like Dublin Core, CIDOC-CRM, SAPO, Geonames, ESE (Europeana) are taken in to account to be analyzed as a starting point to develop an integrated historical linked data system to model cultural heritage buildings.

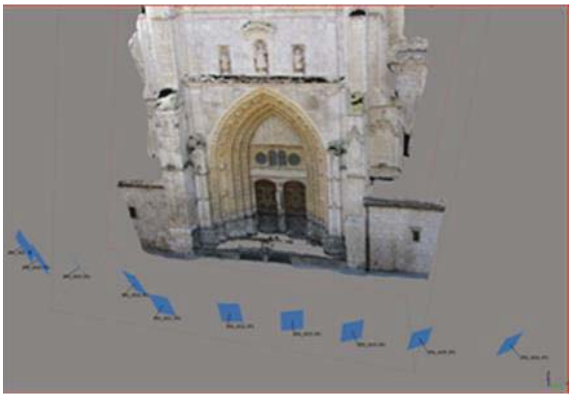
2.3. Software CH Asset management

One of the goals of the INCEPTION project is oriented towards the development of cost-effective procedures and tools for survey, condition assessment and maintenance of cultural heritage assets. Because CH asset management requires non-conventional inspection methods, it is of outermost importance to develop a new method for condition assessment, which is based on predictive analysis (diagnostic, conservative, morphometric), non-destructive procedures (thermal imaging, level of reflectivity, integrated sensors, spectrophotometry, ultrasonic surveys), supported by economically sustainable tools and devices.

Outside the domain of cultural heritage, asset management has been developed as an important knowledge field both in science and practice. Standardised methods are also available, for instance ISO 55000 (PAS 55) on asset management and Dutch NEN2767 on technical condition assessment. These methods are used in combination of performance-based maintenance contracting. The INCEPTION project has analysed the existing software tools for condition assessment, and selected a state-of-the-art solution for further advancements and implementation for CH asset management. The solution is based on the innovative software RE SUITE –a complete software package that allows various components to be easily automated. Using RE SUITE, all types of users can collect, structure, analyse and disclose the asset information. The solution is able to centralize all the information / results from various software applications in order to cost-effectively manage all project information and key business processes across the building's or system's lifecycle.

CH asset management in INCEPTION aims to progress beyond the state-of-the-art by progressing from a "cure" (responsive) to a "care" (preventive) approach. The innovative "care" approach comprises proactive and integrated management of CH assets whereby regular maintenance and periodic monitoring substantially anticipate, prevent and minimize damages and losses. For this purpose, INCEPTION approach towards CH asset management focuses on quality assurance, starting from a profound preliminary analysis; followed by a well-founded diagnosis; and completed with the inspection of the efficiency of executed interventions and a system of periodic monitoring.

2.4. 3D data capturing



The increasing development of 3D laser scanner technologies allows to create high definition databases based on even more detailed three-dimensional morphometric data. These "digital archives" are an extremely valuable research tool in cultural heritage field, although there are still some limits to the exploitation of 3D models obtained by laser scanner survey. The growing numbers of un-exploited 3D models points out the need for innovative methods that could benefit from the informative value provided by new systems for surveying and representations as well as data management tools. The development of high quality 3D models in specific conditions, such as in Cultural Heritage field, is still time-consuming and expensive, and generates too large data. Furthermore the outcome of digital reconstructions is frequently provided in non-interoperable formats, and not easily accessible too.

INCEPTION proposes a substantial enhancement in the efficiency of three-dimensional data capturing procedures and devices, especially their suitability and aptitude for the physical cultural resources and assets: cultural heritage sites, historical architectures, archaeological sites and artifacts that are characterized by smart handling of non-conventional characteristics, location and geometries.

Moreover, research challenges aim to break through the barriers caused by segmentation in collecting documentation data, closing the gap regarding the absence of a common protocol based on survey methodologies and technological integration.

3. FOCUS ON R&D IDEAS OF THE H-BIM PLATFORM

The INCEPTION project and specifically the H-BIM platform will face many challenges. One of the base and unique ideas of INSITER is the Time Machine, a more detailed description can be found in 3.1. The H-BIM Platform itself and technical challenges that have to be tackled developing it can be found in the next paragraph 3.2. Important end-user results as the front-end applications about Virtual Reality & Augmented Reality will be discussed in 3.3.

3.1 Time Machine

One of the main challenges of the INCEPTION project is to realise innovation in 3D modelling of cultural heritage through an inclusive approach for time-dynamic 3D reconstruction of artefacts, built and social environments. The so-called INCEPTION "Time Machine" will be developed as an open-standard Semantic Web platform for creation, visualisation and analysis of 3D H-BIM models of cultural heritage over time, with emphasis on how the modelled cultural heritage evolves over time in association with its built and social environments.

The implementation of the dynamic structure of the platform through models and reconstructions/simulations related to specific historical periods, allows to "move across time and space" enabling features like time-machines, and it is connected also with time planning of interventions. Users will be provided with a dash board for accessing survey data, i.e. cloud of points, and building 3D historical simulations.

A possible data model to manage the "time dimension" in cultural heritage 3D models is through ontologies. Semantic data model has been applied and exploited in several ways in virtual museum and cultural heritage artefacts but time representations have always been a critical point: time as a measure is a mathematical entity but it is also descriptive and in this domain events are closely interlaced with non-tangible properties like architectural styles, environment description, authors and usage which often have not a strictly defined time span. Time definition is also used by related documentations about the building, so in the Time Machine tool properties linked to the model should be available for a specific period of time. Another issue is that in cultural heritage domain time is not always known or perfectly indicated on specific events or could be defined in relation with other events.

Having a consistent time data model (from geometrical modelling to physical properties, and linked to related information and documentation) gives clear advantages for a global integrated paradigm but this application has to be efficient by all possible access points: it has to have an effective interface to serve the Time Machine tool, it has to be integrated in the semantic search engine and eventually it has to be exposed as linked data without any conversion.

The use of semantic data model is a bottom-up solution that could take care of most of those domain distinctive features, because ontology models are by definition inclusive and flexible.

The choice of an ontology related to an event or a time span is also related to the fact that semantic ontologies are not only knowledge representation that gives a logical framework through the use of mathematical properties to harmonize data sources, but they are related to two very important features: the capacity of enriching the domain knowledge by automated reasoning (the ability to logically infer new data from formal properties) and a formal query language (SPARQL) that could be integrated in different IT frameworks.

Different references mean different meanings and applications, so that define a time span for a physical entity could imply an evolution, transforming it in another entity, or its replacement; physical properties related to the style description should deal with their relation with the model changes through time, some not precise phrasal indication (e.g. in the mid of seventeenth century) in related documentation has to be taken in account and granularity of time measure could affect performance and usability.

3.2 H-BIM Platform

The H-BIM platform makes use of Semantic Web technology to store semantic knowledge from the Cultural Heritage. However the platform needs to deal with several data sources and data formats, many of them in first instance likely hard to cover with Semantic Web Technology.

One of the other important formats are point clouds. Point clouds are large amounts of data; even with current modern systems it is hard to handle the amount of data generated by scanners. State-of-the-art professional CAD applications are often not able to visualize complete point clouds scans. Dedicated applications are used to visualize these results before included within CAD applications. As the point clouds are becoming more important and availability of scanners increases availability of content and usefulness it is an important area for CAD applications also.

On the other side while semantic web is becoming mature and standards like OWL2 and SPARQL are accepted and used in more use cases as well as its underlying structures are supported by large software companies like HP and ORACLE. The semantic web however has important issues when the original content is scaled. Even moderate sized models can reduce the speed of high-end systems that work perfectly on small toy models into unacceptable slow solutions.

Bringing both worlds of large sized point clouds and hard o scale semantic web together will for sure introduce interesting challenges. Shape recognition will both reduce the size of relevant information as well as increase the computer understandable semantic meaning of point clouds. The boundaries of what is possible over here and in what way this can be automated and make use of advanced semantic web functionality will become an important technical result of INCEPTION in the context of the H-BIM platform.

Another important technical challenge can be found in the availability of open Heritage BIM standards. Current open standards that both support semantics and geometry are not always easy and complete enough to cover the requirements for Cultural Heritage information. Current Cultural heritage standards are often based on existing open or closed standards, use a limited subset of them and cover only a limited subset of what is needed for the H-BIM platform.

Non-professional users as well as experts will need to be able to add information and knowledge inside the H-BIM platform. Still the data stored within the H-BIM platform needs to be consistent and trustworthy. As similar questions also exists outside the Cultural Heritage domain, especially in the context of semantic meaning of knowledge the expectation is that state-of-the-art solutions from other domains can be applied.

3.3 Heritage Virtual Reality /Augmented Reality

The first applications of Virtual Reality (VR) date back to the late sixties, when the first rudimental systems tried to replicate an idea coming from literature and cinema. Fifty years later the gap between the user experience in a real environment and a virtual one is still quite wide, mainly because today technologies are still focused only on two out of our five senses.

Nevertheless, combining real environments with virtual objects and information and vice-versa (real objects and persons in virtual spaces) is leading the way to new important business applications based on the relatively new concept of Augmented Reality (AR).

Milgram and Kishino (1994) helped clarifying the panorama by defining four environments: the real environment, the virtual environments (computer generated and unrelated to real world), AR (the real world is the backdrop for computer-generated contents) and Augmented Virtuality (real-world data and objects immersed in a virtual environment).

Yuen et al. (2011) gave a good overview of the main application fields where AR is taking a growing role in redefining the way of working, such as advertising and marketing, architecture and construction, entertainment, medicine, military applications, travels and education.

For the end-users, the purpose of VR and AR deployment in INCEPTION is to allow 3D semantic model utilisation for queries, visits, uploads and downloads and access through apps that facilitate an analysis of needs, behaviours, expectations of CH customers and operators.

The models will be delivered through INCEPTION Platform in already existing Apps for a myriad of purposes. With this feature, the models will be utilised for research, tourism, building maintenance, specific studies, etc. It will be tested also using Virtual and Augmented realities applications on tablets and smart phones.

INCEPTION investigates the possible use of the standard format for Augmented Reality, i.e. ARML, developed within the Open Geospatial Consortium (http://www.opengeospatial.org/projects/groups/arml2.0swg). Whenever relevant, INCEPTION will also employ knowledge and guidelines from the EuroVR – European Association for Virtual Reality and Augmented Reality (http://www.eurovr-association.org/), the European Project International Augmented Med (http://www.iam-project.eu/), and from certain EU research projects, like Archaeoguide and Veritas.

Moreover, the digital model generated will be readily exported to VRML, X3D or equivalent formats which are appropriate for: VR/AR applications; multimedia edition; conceptualization in a computer scenario; and historical recreations.

4. CONCLUSION

The INCEPTION project has just started and within this project we are just starting to find the context, state-of-the-art and possible solutions for a Heritage-BIM Interoperable Platform.

Nevertheless the team with an unique combination of knowledge and background available within BIM, Semantic Web, Server/Platform solutions and Cultural Heritage solution enables the potential to deliver an interoperable platform that serves CH inan unique way. Making use of Semantic Web techniques and open BIM standards the H-BIM Platform can become the intermediate for Cultural Heritage information forever, for everybody, from everywhere.

The first prototypes, platform architecture and solutions to the challenges named will be available in spring of 2017. The following year more detailed beta applications and developments will become available including a beta version of the H-BIM Platform. Within the last year of the INCEPTION project the prototypes and beta developments are tested and further improved.

Within INCEPTION the solutions and developments towards the technical challenges are backed by 6 project demonstrations from Italy, The Netherlands, Spain, Cyprus, Croatia and Greece. These project demonstrations concern real use-cases that will show the potential and possibilities of the solutions and are expected to be followed by many more in order to store, understand and make available Cultural Heritage information and its contexts to both professionals as non-professional users.

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Common Strategies and Avant-garde Approaches in Terrestrial Laserscanning

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Abstract. Over the years, terrestrial laserscanners evolved in terms of speed, accuracy and range. Key aspect of a successful project is an efficient workflow of data capturing and pre-processing. Latest novel developments in hardware and software allow to drastically reducing field and office time, affecting each stage of the workflow: Scan Location Planning, Data Capture, Filtering/Cleaning, Registration and Analysis. Moreover, automatic registration algorithms improved recently. However, a good pose estimation, user-defined or with the help of further sensors can reduce the processing complexity dramatically, especially in large projects. In addition, these sensors open up the possibility of real-time registration in the field, shifting the pre-processing stage into the field. Additional data acquisition sensors were combined with laserscanners, such as integrated HDR cameras or calibrated external infrared cameras. This allows on a first worldwide holistic approach to automatically assign an RGB together with a temperature value to each geometry pixel and to analyse the scenery with new aspects which opens up new workflows.

1. CURRENT STANDARDS OF 3D TERRESTRIAL LASERSCANNERS

In the years around 1998 the terrestrial 3D laserscanner technology reached the civil market as commercial products and rapidly evolved. Initially with a rigid limited field of view the devices qualified as valuable entry to the family of professional survey technology. Generally seen, while in the first decade improvement of technical specifications and processing software took place, the beginning of the second decade showed the integration of additional sensors.

Today’s high end class of static 3D terrestrial laserscanners has - with exceptions - some general characteristics. The models are based on a stand-alone concept. Power supply, data storage and the control panel have been integrated on-board in order to avoid additional packages and sensible connection cables during the operation. The panoramic horizontal field-of-view (360°) is widely adapted and the vertical field-of-view reaches up to 320°. Ranges vary from thirty to several hundreds of meters, even kilometers in some cases and scanning speed has already passed the 1 mio px/sec data rate. Certifications on eye safety (laser class 1) and ingress protection (IP class 53 and higher) have been reached. The operability is given in many cases at temperatures below zero degrees centigrade. Some do have Wi-Fi connection which is mainly used for remote control.

2. OUTPUT DATA

2.1. 3D Laserscanners

The heart of a 3D laser scanner is given by the electronic distance measuring device, the mechanical deflection unit of the laser beam and the controller. The capturing process works point wise in a polar system by reading the deflection angles and the range with the laser range finder.

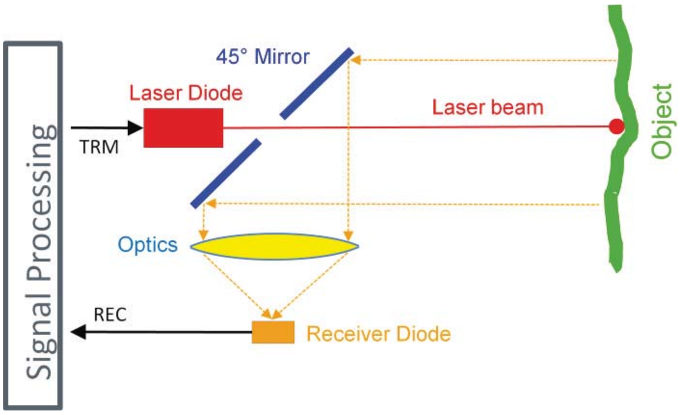

Fig 1. Technical principle of a laser range finder.

The individually altering reflection ratio of each coordinate has visual reading properties of different materials of the captured surfaces when applied on a grayscale. This intensity value depends mainly on the surface reflection properties, the distance to the sensor and the incident angle of the laser beam.

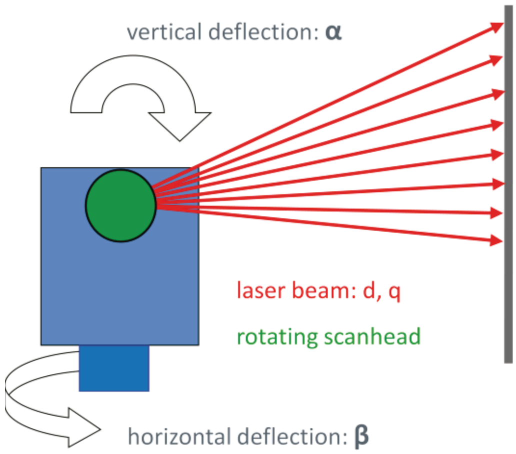

Fig 2. Operation principle of a 3D terrestrial laserscanner.

During operation the device gets mounted on a tripod being fixed at its base. The laser beam is sent out and deflected in a vertical plane (vertical deflection) via a rotating mirror while the system itself rotates horizontally (horizontal deflection) resulting in spherical sensing of the surroundings.

A panoramic laserscan typically consists of about 12 – 50 million coordinates which are saved in a file as a point cloud. The capturing result is a cloud of spatial coordinates (x, y, z) with intensity values. Both are stored inside the Z+F scan file format *.ZFS which is linked to a Z+F project file *.ZFPRJ.

2.2. Additional sensors: the High Dynamic Range (HDR) camera Z+F I-Cam

Since laser light uses a certain wavelength, the measured data results monochrome at the wavelength of the emitted laser light. By evaluating the signal level of the backscattered laser light (measured intensity) it is possible to generate gray scale reflectivity image.

For a long time photographic color information had been of auxiliary use for orientation purpose. The introduction of HDR technology significantly helped to establish it as a valuable additional information layer on scan data. Valuable color information enhances significantly the analysis and assessment of materials by their visual state. For instance, industrial environments use color coding in conducts for communication of fundamental properties, e.g. blue = cold / red = hot / yellow = gas. Nowadays, accurate color information is considered indispensable for surveys of cultural and architectural heritage, where the documentation value is very high.

Manual alignment of color information to the scan data is complex and prone to errors. Modern laser scanners record the color information of the surrounding area by additional internal or external sensors using an additional work cycle right after the 3D capturing. The camera is directed to a number of predefined positions from which the relevant surrounding areas are captured. Devices with a rigidly integrated camera allow applying a predefined calibration protocol in order to match each camera pixel to the corresponding scan pixel by known transformation parameters fully automatically and with constant accuracy. Therefore the result arrives rapidly and has a constant and reliable quality. The raw color data is stored in a ZFI file (Z+F imagery) and after processing in a JPG / PNG.

Fig 3. Device with integrated camera (center) and accessorial headlight (top right).

Fig 4. HDR colored point cloud in 2D view (extract). Architectural details, e.g. the roof overhang, are documented without loss due to interferences with incorrect exposure times.

For some devices it is possible to extend the application range to dark environments up to complete darkness, using accessorial headlight with directed LED emitters. Within indoor ranges it improves significantly the color result and avoids disturbing shadows.

Fig 5. Bundle of raw imagery from the Z+F I-Cam with different exposures for HDR processing.

The integrated High Dynamic Range technology allows operation under light conditions of high contrasts, which is common in laser scanning applications especially when using full panorama views. By the use of exposure series the correct color information is being detected also in these parts which conventionally would result under- or overexposed. A bundle of images is captured for each camera position. The final panorama is generated pixel-by-pixel from the best exposure values. Therefore, photographic color mapping of point clouds is possible even in conditions of extreme contrasts.

2.3. Additional sensors: Infrared camera Z+F T-Cam

As first manufacturer Z+F introduced a calibrated thermal camera with a one-click full panorama processing solution (Z+F T-Cam) which associates a temperature value with each geometric point.

Manually merging of thermal imagery to point clouds had been quite complex because their extremely different resolutions. The lower level of detail of thermal images impacts negatively on manual assignment of homologous points between them. Hardware with higher resolution still hardly matches the integration conditions such as on energy consumption, cooling, size and weight.

Fig 6. Accessorial infrared camera Z+F T-Cam.

Fig 7. Thermal analyzing tool with and without enhanced visibility by the transparent point cloud allows (left).

The Z+F T-Cam is a calibrated compact add-on camera and is controlled and powered directly from the scanner. Within one single cycle the temperature information of the surfaces is captured in an additional step (after the geometry and RGB color). Similar to the integrated color camera I-Cam, the software applies the automated color mapping to the scan data 0. The parallax effect induced by the offset position is negligible at architectural scale. The visual data combination of scan and infrared imagery is enhanced by toggling dynamically the transparency. The high resolution of the scan data allows the sharp and accurate definition of the geometries (e.g. edges and borders) while the thermal data shows the temperature on the surfaces with less resolution.

The T-Cam allows using temperature as further criteria for analysis, segmentation and classification of scanned objects. Color information may provide knowledge about the condition and contents of an architectural element. Thermography may provide time-related knowledge about heat distribution on the surfaces. Further it allows detecting, locating and identifying the presence of damages such as cracks and leaks by indirect reading of dynamic effects, e.g. temperature changes by evaporation.

The raw data of the thermal camera is stored in the format *.IR.ZFI (Z+F Infrared imagery) and after processing in *.JPG /PNG and *.IR.TIFF.

3. COMMON PROJECT WORKFLOW IN STATIC 3D TERRESTRIAL LASERSCANNING

Survey projects are generally articulated in field work and office work. In comparison to conventional survey methods (direct, indirect, manual, digital etc.) where the operator classifies the geometrical elements already in the field and transcribes them with his own abstraction to a scaled deliverable, the laserscanning survey has a different character. On site, it is a panoramic capturing at a defined resolution but without any classification of the captured geometries. The interpretation of the geometries is disconnected from the site in place and time.

3.1. *Conventional workflow with targetless registration*

The laserscanning survey is structured in a data capturing phase in the field, the successive assembly of the scans (registration, together with filtering and coloring) and then the data interpretation phase, both in the office.

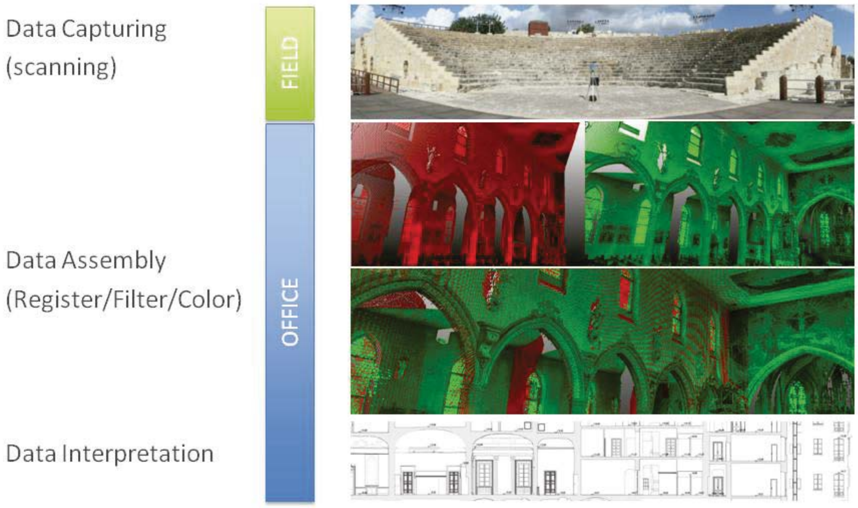

Fig 8. Conventional workflow in terrestrial 3D laserscanning.

4. THE BLUE WORKFLOW: AN AVANT-GARDE APPROACH

The data assembly bears the risk of failure during the registration which is always connected to extra costs when appearing back in the office. The risk varies with the applied registration method.

Target registration methods generally have higher reliability, but are a factor of additional effort and have limitations when used without redundancies.

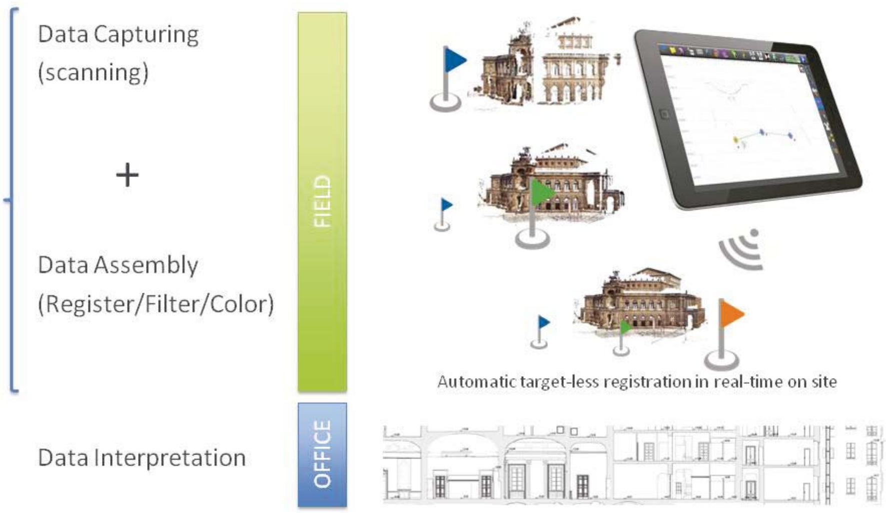

Fig 9. The Blue Workflow introduced by Zoller + Fröhlich in 2015.

Registration methods without targets by form (cloud-to-cloud) or by fitted planes (plane-to-plane) allow waiving the additional target setups in the field, but demand extensive hardware resources for processing. They are sensible to fail because of missing overlaps between scans and high ratio of moving objects. Often the processing may require intervention by an operator in case of failure, at any time during the cycle which is a limitation for overnight batch processing.

Zoller + Fröhlich developed the *Blue Workflow* which is a novel approach designed strictly on user needs by shifting the data assembly phase from the office to the field. The Blue Workflow is available for use with the product Z+F IMAGER® 5010X and its tablet software Z+F LaserControl® Scout.

The solution synchronizes the incoming scan data to a tablet-PC, performs an automatic real-time registration. Further efficient auxiliary tools allow manual correction and the optimization of the registration (fine registration) to be done as background operation during idle times.

As a result, the operator leaves the site with the already registered project and may proceed in the office immediately with data interpretation. For full flexibility, the user may switch between the Blue Workflow and the conventional workflow at any time and without technical limitations.

4.1. Automatic target-less registration on site and in real-time

The risk of additional cost infliction due to registration issues is a negative factor regarding the efficiency of targetless surveys, since causing a higher demand of redundancies in the field. In other words, the dilemma is in the ratio between cutting off the extra effort of target set-ups and increasing significantly the number of scan positions not only for the required overlaps, but in order to be on the safe side during registration. The Z+F solution is based on the cloud-to-cloud registration principle, but allows flexible integration of all other methods.

4.1.1. Requirements.

Shifting the critical assembly phase from the office to the field allows for the first time to take countermeasures immediately and directly on site. The operation needs to harmonize with the frequency of setting up the scan positions in order to avoid any additional time or delay.

The mandatory hardware requirements are:

- An external data computation unit such as a tablet PC for off-board processing, physically and logically independent from the scanner.
- High-speed wireless data exchange between the scanner and the tablet PC.
- Wi-Fi signal at extended range.
- Additional sensors for pose estimation of the scanner, with indoor and outdoor capabilities.
- independence from battery runtime of the tablet PC.

The mandatory software requirements are:

- Close to real-time processing of the registration.
- The result needs be immediately available for evaluation and eventual countermeasures.
- Efficient correction tools are needed in case of negative outcome.
- All additional basic processes must fit within the tight time window of the typical retention time in a scan position (a couple of minutes).

4.1.2. Positioning sensors for automatic registration.

Z+F LaserControl® Scout is based on the cloud-to-cloud registration principle which is able to perform without any additional preliminary processes, such as indexing. Initial alignment of two scans is mandatory for cutting processing time since the algorithm iteratively searches by radius for matching point groups.

The initial alignment is done by the system automatically. The data derives from additional positioning sensors, such as GPS and IMU (positioning, with indoor and outdoor capability for stop-and-go scans), barometer (height) and compass (orientation). The pose estimation is sent together with the scan file from the scanner to the tablet and gives the relative position and orientation to the preceding scan.

Fig 10. The Z+F IMAGER® 5010X with integrated indoor and outdoor positioning system for stop-and-go operation. It tracks the movements while being carried and estimates the set-up position and scanner orientation. Two dual-band antennas for data transmission and remote control allow constant synchronization with the Z+F LaserControl® Scout tablet.

4.1.3. Cloud-to-cloud registration with real-time performance.

In order to achieve the sufficient performance for real-time operations, the cloud-to-cloud registration principle is split up in two requisitions:

A) Creation of connectivity between two scans (evaluation factors: overlap, resolution, noise)

B) Computing of the maximum registration accuracy by iterative algorithms

The interrelations between the requisitions are:

- If condition A is positive, then the result of B is also positive and improves by processing.
- If condition A is negative, then B is obsolete. Corrective countermeasures need to be applied by the operator.

These requisitions have the properties:

A) Rapid computation if computed in 2D. Positive result will also apply for 3D

B) Complex 3D computation which can be done during idle times in batch mode. Negligible risk of failure, if A is positive

The result has the potential of an extremely rapid field-registration tool used as a reliable verification of the connectivity between scans and a subsequent robust optimizer tool for batch processing.

Fig 11. Next incoming scan and placement in estimated position by navigation sensors. Automatic 2D registration or manually as corrective tool with maximum moving radius resulting in a verified connectivity and alignment.

4.1.4. Correction tools.

Immediate countermeasures consist either in individual parameter setting for the computation or in correction of resolution (by doing a subscan) or in adding overlaps (from an intermediate scan position).

The Z+F solution proposes intuitive and efficient manual tools at two levels of complexity. The first tool is based again on 2D matching principle of the ground view, but with manual adjustment in position and orientation and further of the allowed maximum moving radius (figure 11). The more restrictive the radius, the more robust becomes the computation. Further, this is a powerful tool to avoid false positive results due to geometrical similarities of repeated structures. The second tool is a real 3D computation of two scans with an intuitive manual alignment interface. The two tools can be combined and enhanced by manual modification of the relation between scans. These tools have touch-screen optimized interfaces for tablet-PC.

4.1.5. Extension of the Blue Workflow

The introduction of an external tablet PC with full control of the real-time model building process keeps a vast potential for additional features.

4.1.6. Support for external scanners.

Scanning with a handheld device of hidden areas, details or any filigree decorative parts of a scene, such as capitals of columns or sculptural elements, while the static scanner is capturing the overall scene is very efficient. The external scan data can be transferred to the tablet PC and registered to the project. It is possible to synchronize the scan data directly to the project of the Z+F scanner and register it on-the-fly.

Fig 12. Synchronization with external sensors for integrated use. Advanced automatic synchronization allows upload from handheld scanner (e.g. DotProduct DPI-8) to Z+F IMAGER® 5010X, insertion to the running scan project and instant transfer to the tablet for manual registration into the current digital model.

4.1.7. Additional batch processing.

The real-time automatic registration feature is optimized for operating parallel to the active capturing cycles of the scanner device. The operator alters between moving the scanner to the next position and registering the incoming scan with the previous position. Time in between operation of the scanner can be used for batch processing, such as fine registration, coloring and filtering.

5. THE BLUE WORKFLOW AND INCEPTION

The instant full control over the digital model directly on site allows re-thinking the terrestrial laserscanner as an instant tool for verification, documentation and assessment. The Blue

Workflow has created an ideal platform for context specific features such as in Cultural Heritage. Having the complete digital model instantly in hand is the basic practical condition for enriching the captured geometry with intelligence, while still on site.

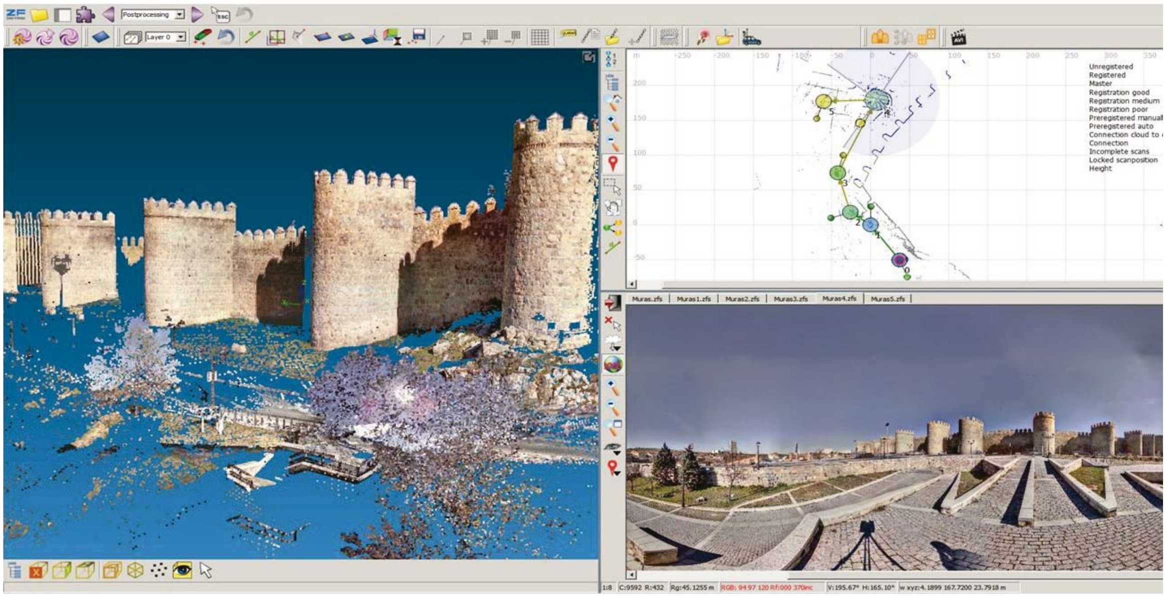

Fig 12. Visual state of the scan project at the end of field work. Times during logistics have been used for complete batch processing, such as fine registration, filtering and HDR coloring.

The holistic approach of the Horizon 2020 project Inception for Heritage-Building Information Modeling (H-BIM) includes purposeful data collection already from capturing level. The Blue Workflow is the ideal environment for the insertion of differentiated and context-sensitive tools.

6. FIELD VERIFICATION OF THE BLUE WORKFLOW

Our methodology has been tested in two different case studies on the Island of Cyprus. The first selected site was the Archaeological Site of Asinou, which is a byzantine Church and the second was a Greco-Roman time period Amphitheatre of the Kourion Archaeological Site near Limassol which is the second biggest city on the island.

Both case studies are not only remarkable sites, but also very unique for the implementation and testing of our methodology. Moreover, their exposure to environmental factors such as earthquakes, high temperatures and humidity are challenging the e-documentation of the two unique sites.

6.1. Case study: Church of Panagia Phorbiotissa of Asinou

The famous Byzantine painted church of Panagia Phorbiotissa of Asinou is situated about five kilometers south of the village of Nikitari in the pine-clad of the Troodos range of mountains, at an altitude of approximately 450m. The church is dedicated to the Virgin Mary and is considered to be one of the most important Byzantine churches in Cyprus. The main church is the only surviving part of the Phorves monastery from which the name Panagia Phorviotissa originates. The church is dated from the early 12th century AD and the murals inside range from the 12th century through the 17th century. The church is recognized as a World Heritage Monument by UNESCO, as it is home to perhaps the finest examples of Byzantine Mural paintings of the island.

The church is a rectangular vaulted, humble-looking building with arched recesses in the side walls and transverse arches supporting the vault. It is built with local volcanic irregular stones originally covered with plaster in such a way as to imitate marble revetment. The church is covered with a steep-pitched roof and flat tiles. The original pies with the transverse arches where strengthened with additions at a later date. The apse of the church was also reinforced with additions at a later date. A narthex, with two semi-circular apses and calotte and a drumless dome, and apsidal north and south ends, was added at the west end at about the end of pitched roof with flat tiles, which appear in the model of the church in the donor composition, and therefore is original. The structure was built in the 12th century by the Greeks, who also built the nearby ancient city of Asinou. The transverse arches where strengthened with additions at a later date. It appears that the church suffered great damage at the end of the 13th, or beginning of the 14th century as the result of an earthquake. The apse was then rebuilt and the apse semidome and nave were redecorated. The narthex was redecorated in 1332/3. Thus the frescoes surviving in the church of Asinou today vary in date.

Fortunately, two-thirds of the original decoration of the church of 1100's survives today. Through these murals we are able to determine that the church was probably originally constructed as a family chapel for Nicephoros Magistros (who later died here in 1115 AD). One inscription found in the south-west recess records that the church of the holy mother of God was painted through the donation and great desire of Nicephoros Magistros the Strong, when Alexios Comnenos was Emperor in the year 6614, indiction 14. This probably means that the church was constructed sometime between the year 1099 and 1105. Another inscription mentions that the founder was also called "the Strong", an appellation most probably given to him by the people for his power and severity as a judge, or taxation officer. The inscriptions mention neither a Monastery nor the appellation "Phorbiotissa".

6.2. Case study: Amphitheatre of Kourion

Kourion / Curium, an ancient Greek city on the southwestern coast of Cyprus, the surrounding Kouris River Valley being occupied from at least the Ceramic Neolithic period (4500-3800 BCE) to the present. The acropolis of Kourion, located 1.3 km southwest of Episkopi and 13 km west of Limassol, is located atop a limestone promontory approximately 43-51m in height along the shore of Episkopi Bay. The Kourion archaeological area lies within the Akrotiri Sovereign Base Area, which forms part of the British Overseas Territory of Akrotiri and Dhekelia.

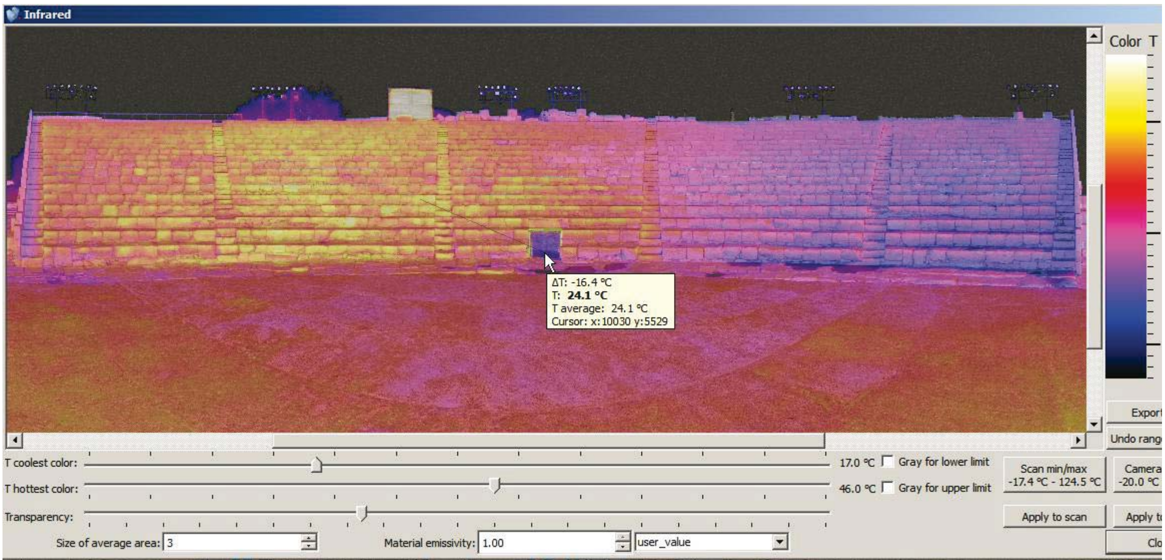

Fig 13. Thermal analysis tool in Z+F LaserControl® Scout for on-site assessment.

In the Cypro-Archaic period (750-475 BCE) the Kingdom of Kourion was among the most influential kingdoms of Cyprus. In 672 Damasos, king of Kourion, is recorded as a tributary of Esarhaddon of Assyria as Damasu of Kuri. Between 569 and approx. 546 BCE Cyprus was under Egyptian administration. In 546 BCE Cyrus I of Persia extended Persian authority over the Kingdoms of Cyprus, including the Kingdom of Kourion. During the Ionian Revolt (499-493BC), Stasanor, king of Kourion, aligned himself with Onesilos, king of Salamis, the leader of a Cypriot alliance against the Persians. In 497 Stasanor betrayed Onesilos in battle against the

Persian general Artybius, resulting in a Persian victory over the Cypriot poleis and the consolidation of Persian control of Cyprus.

Our second case study: The Kourion Amphitheater, initially constructed in the 2nd century BC, was relatively small. Renovations in the mid-1st century and at the beginning of the 2nd century reconstructed and expanded the theatre. In the early-3rd century the theatre was renovated to accommodate gladiatorial games. The theatre was abandoned in the later-4th century. The cavea could accommodate 3,500 spectators. The stage building (scaenae frons) is preserved only in its foundations, though this would have originally obscured the view of the Mediterranean to the south. The theatre has been completely restored and is used today for open air performances. It is one of the venues for the International Festival of Ancient Greek Drama.

6.3. The results

The missions to the UNESCO WHL monument Asinou and the Kourion amphitheatre have been very valuable, due to the unique opportunity to fully use the hardware and software above. The entire interior and the exterior of the monument have been scanned in an extremely short time window: six hours. By the end of the day we had the exact 3D structure, the Infrared values and the photographic Texture of the entire monument.

The following images are illustrating the exact, amazing and unique results, which have articulated for the first time at the full assembly meeting of the Sub-Committee for Culture, Diversity and Heritage of the Council of Europe in Limassol in November 2015.

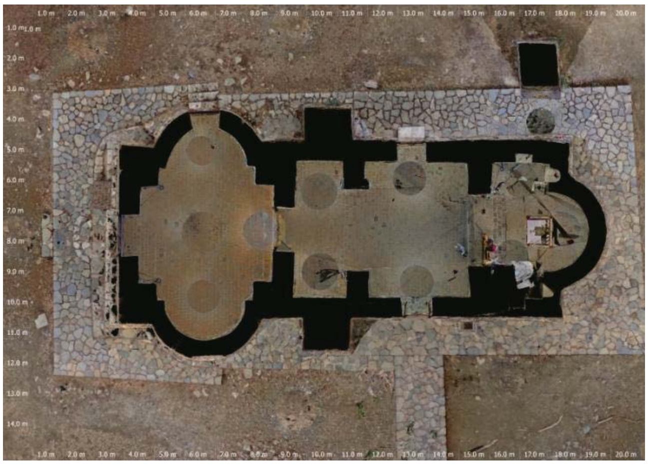

Fig 14. Ground plan of Asinou church from the point cloud.

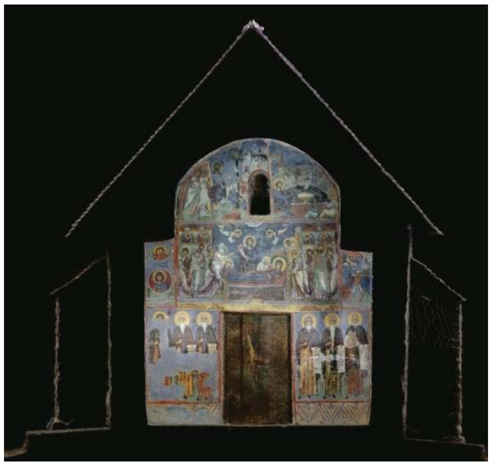

Fig 15. Section view with HDR colors of the decorations (Asinou).

7. CONCLUSIONS

In this paper we presented a novel hardware and software infrastructure for the holistic digitalization and 3D modeling of important Cultural Heritage monuments. The system can work under unusual extreme conditions and can be used for any kind of buildings / monuments. The advantage to be able to update the holistic 3D models on site and on-time is worldwide unique and a breakthrough for the area of Cultural Heritage digital documentation.

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Digital Documentation: Sustainable Strategies for Cultural Heritage Assessment and Inspection

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Abstract. As part of 3D integrated survey applied to Cultural Heritage, digital documentation is gradually emerging as effective support of many different information (photos, texts, non-destructive diagnostic analysis, multi-resolution images, historical data, etc.) in addition to the shape, morphology and dimensional data. Sustainable strategies in heritage documentation can be achieved through the implementation of effective data collection processes and the development of semantically enriched 3D models. Advanced 3D documentation methodologies identifying different layers of data to be recorded for heritage applications is one of the main outcome of the European Project "INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic modelling", funded by EC within the Programme Horizon 2020. Technical information will be processed in order to contribute to the creation of a documentation and data acquisition protocol, aimed at identifying sustainable strategies for conservation, refurbishment, reuse and enhancement of heritage buildings and sites. The contribution will deepen in particular the integration of different documentation techniques to enable understanding, interpretation and sharing of collected data.

1. INTRODUCTION

Heritage documentation is basic for understanding our legacy and our cultural identity. The building inspection as well as the documentation processes are becoming more and more relevant and effective in order to collect data and information allowing knowledge, understanding, assessment, preservation and manage intervention on cultural heritage.

While traditional methods and tools of "direct" survey and documentation remain an essential approach to analyze and investigate the main features regarding heritage sites, new technologies and instruments now available allow to create integrated digital databases able to collect dimensional data, information related to structures and materials, state of conservation, diagnostic analysis and historical data, making the data capturing an overall integrated process in supporting sustainable decision strategies for conservation, restoration, refurbishment and enhancement of cultural heritage.

Methods and processes for data collection are continuously developing and today are characterized by an effective interdisciplinarity.

Skills on 3D laser scanner survey, diagnostic procedures and historical researches, as well as about environmental condition assessment or management of metric and dimensional data support the vision of integrated digital documentation for cultural heritage assessment.

Our generation is not able to preserve efficiently cultural heritage and sites due to urban sprawl, pollution, global warming, mass tourism, extreme weather events, etc. We are not able to preserve what we discover and to maintain existing heritage assets and this requires cataloguing and documentation procedures.

The main international and national organizations (UNESCO, CyArk, ICCD, ICOMOS, etc.) that deal with cultural heritage conservation, preservation and enhancement, are increasingly engaged in promoting and spreading processes of cataloguing and documentation. UNESCO recommendations on *Reporting and Monitoring* encourages site managers and local authorities to work towards managing, monitoring and preserving the World Heritage properties.

In this frameworkdigital technologies are very relevant becausethey are able to survey very rapidly heritage building and sites by collecting millions of spatial coordinates. These 3D acquired data can be used not only for documentation and monitoring purposes but also for digital application (such as virtual tours, virtual tourism, digital reconstructions, etc.) and to create integrated 3D database for preservation, diagnostics, restoration, and management procedures.

"Heritage information − the activity and products of recording, documenting, and managing the information of cultural heritage places − should be not only an integral part of every conservation project but also an activity that continues long after the intervention is completed. It is the basis for the monitoring, management, and routine maintenance of a site and provides a way to transmit knowledge about heritage places to future generations".

Heritage recording to capture information is relevant to understand the physical configuration, evolution and condition of heritage sites and objects, and it is the basis for decisions regarding conservative strategies for sites and objects.

Documentation allows to collect information acquired over time through heritage recording and other researches in order to constitute the knowledge base for particular sites and objects.

Information management is the process of acquiring, storing and sharing site documentation to ensure its accessibility, security and reliability.

Different methodologies, instruments, techniques and processes can be used on the basis of the characteristics and features of the object to be surveyed and, above all, on the basis of the different purposes of the building inspection. Moreover, there is a strong relation among data capturing and collection of information and the ability to make decision about interventions or management strategies.

Based on the size, complexity and volumetric articulation of the areas to be surveyed as well as the surface's characteristics or specific environmental conditions addressed, the survey project can be supported by the integration of different methods:

1) 3D laser scanner in order to obtain a 3D metric model;
2) topographic method for the recording of the different scans and for the definition of the overall network;
3) photographic survey for the overall documentation of the monument and the state of conservation;
4) direct survey when a specific check is required;
5) diagnostic macroscopic investigations for the analysis of the state of conservation of the surfaces.

The overall process allowed to obtain a "capital" of metric data, democratic in its use over time: the 3D survey follows an organization able to highlight the steps of its achievement and to retrace the registration process and data fusion. The obtained 3D model, certificate with a certain degree of accuracy and precision related to the performance specifications of the instrument and the complexity of acquisition, is a set of coordinates x, y and z that can be queried by everyone even after the measurement phase.

The degree of flexibility allows to transfer in laboratory processes of organization and interpretation, freeing the acquisition procedure from the metric data representation and making the "capital" of measures exportable, upgradeable and able to be implemented over time. Starting from this "geometric memory" it is possible to extract both geometric aspects for the enhancement of documentation and information for conservation, diagnostics, monitoring and restoration project.

The 3D morphometric survey based on time-of-flight technology (used for large buildings or complexes) can be integrated with topographic survey and optical triangulation scanners (used to survey decorative details, small objects or archaeological remains). High-resolution photographic survey and documentation on materials and structures can be added to the 3D database, while the analysis of the state of conservation (by means, for example, of spectrophotometric survey or thermal camera) allow diagnostic investigation by processing reflectivity index acquired during laser scanning survey.

Via a server, local network or the Internet, it is possible to query the integrated database from PCs and extract different measurement data, surface specifications, two-dimensional CAD drawings, up to three-dimensional printable models.

2. THE CULTURAL HERITAGE INSPECTION

The Cultural Heritage inspection and monitoring could be considered the first step of the maintenance and restoration process.

The main aims of the Cultural Heritage analysis and investigation process are oriented:

- to collect technical information;
- to define the conservation and decay conditions;
- to describe the risk conditions;
- to propose several types of building interventions (maintenance, rehabilitation, re-use and restoration);
- to set-up a detailed maintenance plans and programmes.

The constant inspection and survey activities are necessary to prevent more important decay conditions and are strictly related to prevent damage of the cultural heritage. In fact, one of the most important advantages of the periodic inspection activities is related to the technical information collected in different periods.

Considering that the Cultural Heritage inspection requires relevant historical and technical knowledge as well as the ability to use of specific methods, tools or techniques, only qualified operators should be involve in this task under the supervision of the Project Manager.

Furthermore, it is suggested that a team of expert accomplishes the building analysis (inspection and survey) to reduce the risk of non-conforming interpretations.

In the last years several European countries have developed specific Cultural Heritage inspection activities oriented to collect technical information on the state of historical buildings or sites and subsequent proposed of preventive interventions.

The most important European Cultural Heritage inspection method is the *Monumentenwacht*. This method proposed a visual non-destructive inspection without the employing of innovative technologies. The outcome of this inspection method consists in an “observation report” that presents:

- macroscopic decay,
- recommendation to improve the building qualities and,
- additional investigation by using innovative technologies and tools (instrumental inspection).

Usually, the information collected during the inspection are describe in the Final report and could be recorded and shared in an implementable digital database.

Despite this, today several sustainable technologies and instruments aimed at Cultural Heritage non-destructive inspection are able to collect, at the same time, several digital data.

3. THE 3D LASER SCANNER TECHNOLOGIES AND THE DIGITAL DOCUMENTATION

The collecting information to preventive conservation, monitoring and maintenance of European cultural historical heritage is undeniably connected with the use of specific methods, tools and techniques that in recent years have become technologically advanced and diffuse in all countries.

The innovations of these digital technologies to analyse the Cultural Heritage have been improved and updated in the last decade. The main potential use is related to the rapid analysis of the heritage building and sites.

In this framework the 3D laser scanner technologies allow digital surveys obtaining high definition databases established on even more detailed three-dimensional morphometric scans. The technological evolution of the automatic survey systems represent an important innovation that allows the introduction of the morphology-metric system as an essential support for the setting-up of the three-dimensional databases. The integration of other non-destructive procedures as thermal imaging, index of reflectivity, integrated sensors, spectrophotometry, sonic surveys, etc. allows the collection and addition of other significant digital data.

This typology of database represents the basis of “geometric memory archive” of heritage buildings and sites that can be used for research goals by art and architecture historians, professionals, heritage sites managers, etc., but can also be used for preservation, restoration and environmental protection of heritage assets.

In fact, thanks to the use of laser scanner technology it is possible to obtain a large number of information that can be collected in a “digital archive”.

These “digital archives” are an extremely valuable research tool in cultural heritage field, although there are still some limits to the exploitation of 3D models obtained by laser scanner survey. The development of high quality 3D models in specific conditions, such as in Cultural Heritage field, is still time-consuming and expensive, and generates too large data. Also the outcome of digital reconstructions is frequently provided in non-interoperable formats, and not easily accessible too.

Despite this, it is important to consider the problematic related with the use of the 3D laser scanner. The level of difficulty of 3D laser scanner tool is very high if measured using the following indicators: 1) time, 2) economic cost and 3) required degree of knowledge. This method has to be systematic and efficient in order to avoid inaccuracy, inconsistency and human error. The main problems connected with the efficiency of this survey method are:

- access to all areas to be surveyed;
- target position;
- availability of the hardware storage capacity for large amount of information acquired during the survey;
- post-processing of the acquired data;
- establishment of a database organized by individual architectural elements integrated with a description of additional data;
- concept of “open data packet”;
- management of the outgoing flow of information (byserver infrastructure);
- management of the flow of feedback information(completed with the CAD drawings);
- editing of the final drawings delivered.

For this reason establishing an European standard for the use of the 3D laser scanner in heritage filed could be very relevant and effective. Protocol and standard use could be shared to all European Countries and applicable during the survey and inspection of different typologies of cultural heritage.

The INCEPTION project works in order to implement a common protocol for data capturing, especially in consideration of the use of 3D data capturing technologies.

The protocol will take into consideration the importance of the “digital information” and will be developed analysing the functionalities, capabilities and cost-effectiveness as well as to improve the interoperability and the accessibility of the data.

Another relevant feature regarding the use of the 3D laser scanner technologies concerns the development of 3D semantic models of cultural heritage. Indeed, the data capturing and heritage documentation are strongly related to 3D models exploitation (geometry - metadata - semantic enrichment) and to the optimisation of 3D data acquisition tools.

The 3D semantic models of cultural heritage will also be directly applicable for practical purposes through:

- multilevel organisation of databases applicable for conservation and restoration work, enhancement, promotion, management, and exposition of cultural heritage;
- enhanced point cloud data with highly descriptive quality in terms of material characteristics and morphology (complex geometries and shapes) of cultural heritage;
- inherent indicators for risk assessment of cultural heritage (i.e. environmental risks indicators, safety and security monitoring, unpredictable events management);
- integrated functional distinction of data, shape-related analysis, and semantic information for in-depth studies by researchers and common understanding for end-users at large.

4. THE INCEPTION RESEARCH AVENUES

The European Project "INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic modelling", funded by EC within the Programme Horizon 2020, is focused on:

- innovative technologies for creating 3D models with an inclusive approach to Cultural Heritage;
- the possibility to achieve interoperable models able to enrich the interdisciplinary knowledge of European cultural identity by scholars, researchers and non-expert;
- the development of an open standard platform to "contain", implement and share the digital models.

The project has been selected within the Work Programme *Europe in a changing world – inclusive, innovative and reflective Societies* (Call - Reflective Societies: Cultural Heritage and European Identities, Reflective-7-2014, Advanced 3D modelling for accessing and understanding European cultural assets.

The INCEPTION project, started the last June 2015, will be developed by a consortium of fourteen partners[1] from ten European countries led by the Department of Architecture of the University of Ferrara.

One of the main project' objective is to develop cost-effective procedures and enhancements for on-site 3D survey and reconstruction of cultural heritage artefacts, buildings, sites and social environments.

This research section will be achieved by enhancing the efficiency of three-dimensional data capturing procedures and devices, especially their suitability and aptitude for the physical cultural resources and assets as cultural heritage sites, historical architectures, archaeological sites and artefacts that are characterized by smart handling of non-conventional characteristics, location and geometries.

New methods for condition assessment survey of cultural heritage based on predictive analysis (diagnostic, conservative, morphometric), non-destructive procedures (thermal imaging, level of reflectivity, integrated sensors, spectrophotometry, sonic surveys, etc.) will be developed and will be supported by economically sustainable technologies and devices.

Moreover, the project will propose an essential optimisation of hardware and software instruments for easy scan system, rapid capture of main features/geometric data, and automated data output in an H-BIM environment.

Innovation in documentation of cultural heritage will not involve only data acquisition procedures and hardware and software applications, but the project will set a protocol (guidelines or common methodology) for documenting Cultural Heritage relating to results accuracy and reliability, different sites specifications, historical phases, etc.

INCEPTION equips all actors and stakeholders to cope with the changing roles of reconstruction, preservation and conservation of cultural heritage by:

- closing the gaps between technical fieldwork and modelling in 3D data capturing and the model exploitation for social sciences purposes;
- optimization of 3D data acquisition tools through special set of firmware for cultural heritage, which is able to handle point clouds as well as photo-based data, in order to generate input for H-BIM modelling;
- semantic ontology to identification, recognition and analysis of non-typical geometries, materials, textures, spaces and landscapes of cultural heritage in modelling.

[1] Academic partners of the Consortium, in addition to the Department of Architecture of the University of Ferrara, include the University of Ljubljana (Slovenia), the National Technical University of Athens (Greece), the Cyprus University of Technology (Cyprus), the University of Zagreb (Croatia), the research centersConsorzioFuturo in Ricerca (Italy) and Cartif (Spain). The clustering of small medium enterprises includes: DEMO Consultants BV (The Netherlands), 3L Architects (Germany), Nemoris (Italy), RDF (Bulgaria), 13BIS Consulting (France), Z + F (Germany), Vision and Business Consultants (Greece).

5. CONCLUSION

The integration of digital data and the possibilities of re-use of digital resources is an important challenge for a sustainable protection and conservation (decision-making process) of the historic buildings as well as for an efficient management in the long term.

The digital data alone are not enough to improve the quality of cultural heritage management. It is necessary to consider the elaboration of "digital models and platform" allowing data integration, data accessibility and data updating.

Digital models and platform bring positive effect to the policies addressed to the digitally preserving and sharing the world's cultural heritage in danger and can help the implementation of social initiatives aimed to save specific site in danger.

Integrated digital models, digital archives and "geometric memory" repository can support initiatives aimed to save cultural heritage sites digitally before more are ravaged by war, terrorism, arson, urban sprawl, climate change, earthquakes, floods, and other threats. There isn't enough money or enough time to physically save every site, but digital documentation can contribute with the 3D technology to digitally save these sites to make them available for generations to come.

Last but not least, the creation of integrated documentation platforms is important:

- to provide new documentation procedures for the building preservation;
- to correlate different criteria and indicators that suggest the building decay state;
- to propose advanced diagnostic and data management;
- to take in consideration the building risk assessment.

The aims and the outcomes proposed by the INCEPTION project are very innovative and could create an important impact to preserve, to manage and to study our European Cultural Heritage.

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Diagnostic Integrated Procedures aimed at Monitoring, Enhancement and Conservation of Cultural Heritage Sites

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Abstract. New methods for condition assessment survey of Cultural Heritage based on predictive analysis (diagnostic, conservative, morphometric) and non-destructive procedures (thermal imaging, level of reflectivity, integrated sensors, spectrophotometry, sonic surveys, etc.), supported by economically sustainable technologies and devices, are becoming more and more strategic for monitoring, conservation and regeneration processes. The European Project "INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic modelling", funded by EC within the Programme Horizon 2020, has the ambition to strongly support the development of a pan-European approach to data usage for better decision making related to preventive interventions and for supporting of site management and sustainable exploitation of assets. Software tools for 3D data processing and applications for maintenance and asset management will be developed within the Project INCEPTION in order to increase cross-sector collaboration and knowledge sharing to achieve the main goals of a sustainable, cost effective, no time-consuming, accurate procedure for diagnosis, monitoring and conservation of cultural heritage.

1. INTRODUCTION

The preservation of our tangible cultural heritage is increasingly closely linked to the possibilities of documentation, condition assessment, monitoring and predictive analysis by means of non-destructive procedures. Cultural heritage is nowadays at risk of loss for several causes, such as pollution, urban sprawl, global warming and climate change, mass tourism, extreme weather events, lack of maintenance and human intervention not respectful of the historical and material values of our legacy.

Protection, conservation and sustainable maintenance of cultural heritage is one of the Europe's priority also as a strategy to exit the current economic crisis and build smart, sustainable and inclusive growth, together with the reduction of the environmental impact and the establishment of business strategies for the economic value of cultural heritage.

Heritage management is a strong interdisciplinary filed and many actors are involved in the complex process that, from the documentation up to the restoration, leads to the preservation, enhancement and sustainable exploitation of assets.

In this framework, the European Commission supports more and more various aspects of European cultural heritage research and promotes excellence in heritage in all its forms, supporting in particular: conservation and ICT technologies, disaster resilience and climate change, energy efficiency in historic buildings, underwater cultural heritage, art, culture and humanities, such as the emergence of a European common identity, transnational dialogue and understanding.

The new agenda for EU Research and Innovation on cultural heritage in line with Horizon 2020 sets out in particular three interrelated objectives:

promoting innovative finance, investment, governance, management and business models which will increase the effectiveness of cultural heritage as an economic production factor;

promoting the innovative use of cultural heritage to encourage integration, inclusiveness and cohesion;

promoting the innovative use of cultural heritage to enable sustainable development of European cultural landscapes, seascapes and environments.

The coming, and the increasing development of tools and technologies for the diagnosis and study of the state of conservation of historic buildings was a turning point in the use of scientific analysis for non-destructive assessment and characterization of structures and materials, making increasingly strategic the integrated survey of morphological and dimensional features together with surface specifications.

In this context, the increasingly widespread use of different methodologies and technologies of three-dimensional survey of cultural heritage opens new scenarios that correlate the achievement of three-dimensional models with high metric-morphological precision and accuracy with mapping of the state of conservation, using the database obtained by the 3D survey as multi-layered digital models able to support multiple visualizations of information and surface specifications. This procedure is supported by several European research projects including “EU-CHIC”.

Indeed the EU-CHIC project has demonstrated that there are several methods, tools and techniques to obtain information regarding the cultural heritage. Based on several indicators (e.g. time, costs, level of difficult and number of information collected) the three-dimensional survey of cultural heritage could be considered the most efficient solution.

In the last few years the Department of Architecture of the University of Ferrara developed a series of operational methodologies related to the three-dimensional survey of cultural heritage according to different approaches aimed at different targets and purposes: the 3D metric-morphologic survey in order to achieve 3D databases useful for documenting the geometric memory of historical-architectural heritage; the survey in emergency conditions to estimate the damages and structural assessments, the suggestion and proposal of reconstruction and preservation of the “memory” of the historical artefacts; survey, mapping and verification of unauthorized buildings in historic centres, up to metric surveys integrated with diagnostic methodologies for the conservation of the elevations and surface materials in heritage complexes, buildings and sites.

2. INTEGRATED PROCEDURES FOR DIAGNOSTIC ANALYSIS

Currently projects and interventions related to conservation, preservation, enhancement, refurbishment and reuse of cultural heritage are strictly related to different procedures to assess the state of conservation and general conditions of cultural heritage; starting from an overall documentations and historical researches (including historical construction phases, previous restorations, changes in functions and programs, etc.), visual detection, characterisation of materials and structural conditions, mapping of deteriorations processes and different instrumental diagnostic analysis on the basis of the purposes of the overall diagnostic investigation, the integrated diagnostic survey is the primary tool for decision makers and to define any kind of intervention or management of heritage sites.

Documentation, conservation, retrofitting, enhancement, valorisation and any other kind of interventions addressing the wide range of situations and requirements that cultural heritage presents, need multidisciplinary approaches and many different expertise. New technologies and 3D models interoperability outline new avenues in interoperability and data integration.

As a matter of fact, a specific brunch of the integrated procedures for monitoring the state of conservation toward a sustainable approach to preventive intervention and sites management is related to the “image” or “multi-spectral” analysis; combining 3D metric-morphologic models with mapping and image analysis of architecture surfaces it is possible to exploit useful representations and visualisation of conservative specifications and to extract new awareness and data. Three dimensional representations are an effective tool for studying, detecting and evaluate the transformation of the built environment and its multiple impacts and effects. Three-dimensional models, opportunely processed, not only allow to understand and assess morphological features, but can also be configured as multi-layered 3D data bases for multidisciplinary purposes, including visual detections of material specifications and deteriorations by means of and high-definition digital visualisations for non-invasive investigations.

Fig 1. Example of 3D integrated survey methodologies applied to thefaçade of the Church of S. Carlo in Ferrara, Italy. The 3D time of flight laser scanner survey has been integrated with digital photographic survey, analysis of conservative specifications by spectrophotometric survey and reflectivity index (DIAPReM Centre, Department of Architecture, University of Ferrara).

2.1. *Diagnostic analysis integrated to 3D data acquisition*

Speed and amount of data are the main characteristics that allow the terrestrial 3D laser scanner survey to act as a useful technology for metric and morphological description of architectures and monumental complexes. The evolution of technology for automatic survey is the innovative key factor that allows to input high-density metric-morphological data as an essential support for the setting up of three-dimensional databases able to establish over time a useful archive of "geometric memory" of architecture applicable not only for research but also for conservative purposes and to support restoration projects, monitoring procedures and enhancement of heritage sites.

The high definition metric survey performed by 3D laser scanners produces 3D morphometric models described by sets of millions of coordinates; during the extraction and representation phases, it is possible to perform a multi-scale approach to the metric-descriptive investigation, relating the whole to its details and making the interrogation process reversible. The integration among the 3D laser scannerand the total station (topographic survey) is used to generate a geometric network able to resolve the set of problems relating the creation of the 3D model and the setting up of a coordinate system that allows to relate to each other all or just some parts of the building or complex.

2.2. *State of conservation analysis and diagnostic survey*

The data acquired by means of these integrated procedures (3D laser scanner based on time-of-flight technology, topographic survey, high-definition photographic survey, diagnostic analysis, etc.) are stored in a digital data base aimed at the periodical monitoring of surveyed areas and surfaces and progressive checking of the interventions of restoration. Digital archives allow making it easier to monitor deterioration processes and to plan restoration interventions.

The described procedure can be extremely powerful in monitoring the architectural items and setting up interactive metric databases able to provide at any time information about the surveyed objects. The results obtained until now have shown that it is possible to organize data bases of a great variety and nevertheless complementary to one another, so as to allow a global view of the conservative problem.

One of the main out-come resulting from this integrated procedure is the definition of guide-lines for the interventions on structures and surfaces and the actions for conservation of physical integrity of historical buildings, complexes, city centres and urban landscape or surfaces. This procedure is very useful to develop procedures and operative tools in order to identify, analyse and monitor cultural heritage state of conservation. Some considerations can be outlined in order to point out a possible procedure to exploit the ICT technologies and 3D survey methodologies for enhancement and conservation of cultural assets:

- interdisciplinary competences are needed to preserve the authenticity of the cultural heritage according to the fundamental principles of minimum intervention, compatibility, interpretability and reversibility;
- promotion of maintenance like common strategy in conservation to avoid strong interventions, maintenance of natural assets to enhance the local landscape and use of local materials;
- development of non-destructive techniques and monitoring technologies;
- knowledge of decay mechanisms acting on original materials and structures and identification of critical areas for deeper investigation;
- use of high and innovative technology for no-contact surveying and documentation;
- understanding of accuracy and limits of the technologies, also related to different materials toward a multidisciplinary approach to diagnosis;
- elaboration of databases containing typical damages, testing problems, methods for assessment, diagnosis and monitoring, case studies, structural models, publications, research projects, websites, etc.
- creation of a data base to collect "best practice" interventions, innovative successful technologies, integrated conservative systems, technological transfer, high performance material and technologies and their interaction.

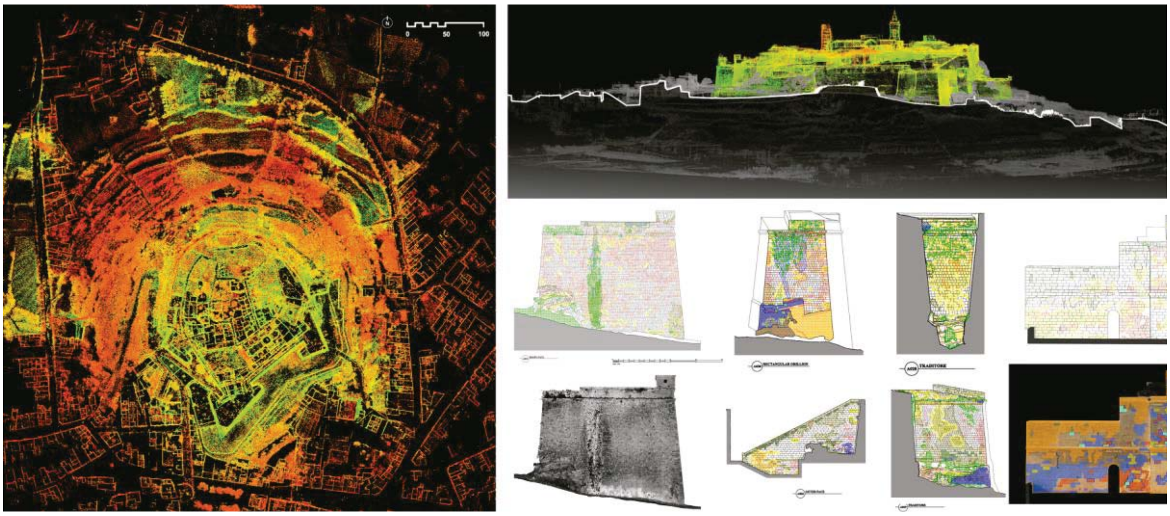

Fig 2. The survey of the Citadel of Gozo, Malta, is an example of high-definition documentation aimed at the restoration project. The primary objective was the 3D detailed acquisition of outer an inner surfaces of the walls, and a complete mapping of the state of conservation of the structures and surfaces.In addition to the purposes of knowledge, documentation and enhancement, the project started from the need to obtain a model for the extraction of accurate two-dimensional representations, a technical and scientific basis aimed at the restoration project (DIAPReM Centre, Department of Architecture, University of Ferrara, and CFR).

3. THE REFLECTIVITY INDEX FOR SURFACES CHARACTERISATION

As part of the integrated methodology of survey of cultural heritage, and in particular in survey methods aimed at conservative interventions on historical surfaces, procedures with the use of 3D laser scanner for the extraction of information for diagnostic evaluation on historical architectural surfaces have been experimented.

By means of time-of-flight technology, in addition to the metric coordinates, it is also possible to acquire the reflectance data of the surface (or reflectivity index), a value that represents the intensity with which the laser emitted from the scanner returns to the instrument itself, and depends on the angle of incidence, the state of conservation and the nature of the analysed material.

The point cloud, the 3D model in which each point is spatially defined by the coordinates x, y, and z, can be displayed in "false colour" mode: the different colours that the software connects to the different parts of the model are related to the reflectance data. The conditions in which the survey is developed (location, light, humidity, etc.) are discriminating for a rigorous evaluation of the reflectance data for diagnostic purposes.

The knowledge of these data enables the collection of information through homogeneous areas on the basis of the angle of incidence and the kind of surface material; the intensity variation from point to point can be used to derive information about materials and the degradation of the investigated surface. Unlike the geometric characteristics, the surface qualities are not uniquely determined and must be carefully interpreted by comparison with other direct surveys. On the basis of this procedure it is possible to extract thematic drawings in which to display the surface areas that manifest different reactions in the reflection of the laser beam.

The accurate use of integrated diagnostic procedures can be an effective tool in the study and analysis of historic architectural surfaces aimed at conservation, monitoring and restoration. Such integrated procedures could be very effective to define guide-lines useful at the future conservative interventions for the preservation of historical centres. By integrating historical documentation, 3D survey, macroscopic analyses and colorimetric characterization, it is possible to collect and merge historical, metric and conservative data.

4. DIAGNOSTIC PROCEDURES FOR HERITAGE CONDITION ASSESSMENT

In the literature and following the analysis of many cases (state of art and on the field), it appears that is very difficult to define a common methodology for the preservation and enhancement of the cultural heritage [10]. A number of criteria borrowed from the study of the context and the market opportunities are what ensure a good result in economic terms and as regards the safeguarding of the building and the site as a whole. In-depth knowledge of the building is necessary, by an assessment of its state of structural conservation and material decay. Only after the diagnostic phase the planner can decide how to proceed and to choose between different techniques.

3D survey methodologies can be used to for the enhancement and conservation of cultural assets, by promoting programmed maintenance strategies and/or to enhance possible re-use strategies without damaging the authenticity of the cultural heritage according to the fundamental principles of minimum intervention.

The main aim of a sustainable approach on cultural heritage is to assess whether the maintenance/restoration/enhancement projects are carefully evaluated to respect the characteristics of the building, otherwise the building itself will no longer respond properly to environmental stress. Orientation and use of natural materials and natural factors such as lighting, energy and ventilation are the environmental elements which characterize historical buildings and which must be taken in consideration when assessing a restoration procedure. According to these criteria, sustainability is not related to an energy class, but to an historical, cultural, cost-efficient planning of the interventions.

In this context, 3D diagnostic procedures represent a very efficient and precise decision-making tool. Digital data-acquisition and storage can be used to manage:

- dimensional analysis of the buildings or sites;
- typological analysis of a typical site, to explain or rule out possibilities for expansion, in keeping with the original type;
- technological analysis to assess the current condition, to a “map of the decay” containing typical materials and structures and their damage;
- technical solutions for preservation or partial replacement (depending on the case in hand and requirements) in an overall maintenance planning.

Technical data is an essential tool in the creation of maintenance and renovation projects. The creation of a database for checking and surveying the “state of health” of a building or a site can be considered as an integral part of the planned strategies for maintenance and the procedures for restoring them, supported by an estimate of the costs of performing. The possibility of planning the level of intervention strongly depends on the assessment of a sustainable monitoring, conservation and regeneration processes that can be summarized in the following steps:

- advanced surveys: non-destructive diagnostic tests onmaterials and forms of degradation, on structures and structural – safety monitoring;
- evaluation of the reversibility of the intervention;
- compatibility of the intended use (in the case of restoration);
- chemical-physical compatibility of the restoration materials (mortars, plasters, etc.);
- structural compatibility compared to the existing structure;
- collection and storage of recyclable materials;
- management of waste from interventions (partial demolition and reconstructions included);
- maintenance of the technical and of existing surface finish;
- environmental optimization of products;
- materials extracted, processed and produced in limited distance (km 0).

Data captured for the definition of an assessment and programmed maintenance or refurbishment method have to be interfaced with the analysis of the regulatory, economic and historic context and also the evaluation of the quality of the market demand and of the local requirements, so as to allow for the quick interpretation of usage and economical potential, and the definition of the peculiar parameters of the quality of the building.

5. INCEPTION PROJECT: APPLICATIONS FOR MONITORING, ENHANCEMENT AND CONSERVATION OF CULTURAL HERITAGE

The European Project "INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic modelling", funded by EC within the Programme Horizon 2020[1], is focused on innovation in 3D modelling of cultural heritage through an inclusive approach for time-dynamic 3D reconstruction of built and social environments.

The project aims to create an inclusive understanding of European cultural identity and diversity by stimulating and facilitating collaborations across disciplines, technologies and sectors; to develop cost-effective procedures and enhancements for on-site 3D survey and reconstruction of cultural heritage artefacts, buildings, sites and social environments; and to develop an open-standard Semantic Web platform for accessing, processing and sharing interoperable digital models resulting from 3D survey and data capturing.

Among the main purposes related to the 3D semantic modelling and wide accessibility of semantically enriched digital models by different users, a specific section of the research is related to enhance the efficiency of three-dimensional data capturing procedures and devices, especially their suitability and aptitude to survey artefacts with non-conventional characteristics, location and geometries. This goal comes under the optimization of a 3D data acquisition protocol, an integrated methodology for Cultural Heritage acquisition in order to close the gap between specialist technicians and non-technical users involved in heritage documentation;

[1]The project, started in June 2015, will be developed by a consortium of fourteen partners from ten European countries led by the Department of Architecture of the University of Ferrara (scientific coordinator Prof. Roberto Di Giulio) which makes use of the facilities and researchers of the Laboratory TekneHub, Ferrara Technopole, belonging to the Construction Platform of the Emilia-Romagna High Technology Network. Academic partners of the Consortium, in addition to the Department of Architecture of the University of Ferrara, include the University of Ljubljana (Slovenia), the National Technical University of Athens (Greece), the Cyprus University of Technology (Cyprus), the University of Zagreb (Croatia), the research centersConsorzioFuturo in Ricerca (Italy) and Cartif (Spain). The clustering of small medium enterprises includes: DEMO Consultants BV (The Netherlands), 3L Architects (Germany), Nemoris (Italy), RDF (Bulgaria), 13BIS Consulting (France), Z + F (Germany), Vision and Business Consultants (Greece). The project has been applied for the Work Programme Europe in a changing world – inclusive, innovative and reflective Societies (Call - Reflective Societies: Cultural Heritage and European Identities, Reflective-7-2014, Advanced 3D modelling for accessing and understanding European cultural assets).

provide a guide to the user and the supplier of metric survey data, explaining expected features in order to achieve the main goals in cultural heritage documentation and data capturing; define a of common procedure for historical data retrieval and possible previous survey; cataloguing and digitization; knowledge of geometric, surface and structural features; analysis of the state of conservation; maintenance of programmatic interventions in the short and long term; outline a list of performance indicators to ensure the effective management of metric survey projects, focusing on the needs and requirements of non-technical users of heritage documentation.

About that, the project will develop new methods for condition assessment survey of cultural heritage based on predictive analysis (diagnostic, conservative, morphometric), non-destructive procedures (thermal imaging, level of reflectivity, integrated sensors, spectrophotometry, sonic surveys, etc.) and will be supported by economically sustainable technologies and devices.

Moreover, INCEPTION solves procedures for registering and handling the index of reflectivity. Defining a novel, practical method for obtaining 3D digital models that clearly show material deterioration is one the main requirement by cultural heritage owners or managing organizations to facilitate detection and decision making on the corrective and preventive measures to be adopted.

An applied research approach will be developed in INCEPTION, based on a combination of state-of-the-art 3D data acquisition, with a tailored computational algorithm for managing the reflectivity index provided by laser scanning devices. A BIM compatible unique digital model, including geometrical, colour and reflectivity information of complex shaped objects, could be readily obtained, thereby favouring not only the cataloguing, but also revealing the probable degradation causes.

Time, expenditure and areas to be cleared up are expected to be clearly defined by the proposed method, which will be implemented through a practical tool for handling 3D point clouds, giving support to current and further automatic procedures.

6. CONCLUSION

Approaching cultural heritage for planning maintenance or restoration purposes requires an in-depth knowledge and clear instructions in order to avoid damaging or compromising the historical identity.

Management policies on cultural heritage must respect the historical and artistic value of the building and should be sustainable and economically efficient. This can be made possible by promoting integrated procedures to identify, analyse and monitor cultural heritage state of conservation to promote out possible communal procedures for the enhancement and conservation of cultural assets.

Non-destructive ICT technologies and 3D survey methodologies allows a wide range of opportunities for the interventions on structures and surfaces and the actions for conservation of physical integrity of historical buildings, complexes, city centres and urban landscape or surfaces.

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3D Integrated Laser Scanner Survey and Modelling for Accessing and Understanding European Cultural Assets

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Abstract. The increasing development of 3D laser scanner technologies allows to create high definition databases based on even more detailed three-dimensional morphometric data. These "digital archives" are an extremely valuable research tool in cultural heritage field: the "geometric memory" is essential for knowledge, protection and sustainable conservation of Cultural Heritage, although there are still some limits to the exploitation of 3D models obtained by laser scanner survey. The growing numbers of un-exploited and "un-interpreted" 3D models points out the remarkable need for innovative methods that could benefit from the informative value provided by new systems for surveying and representations as well as data management tools. The development of high quality 3D models in specific conditions, such as in Cultural Heritage field, is still time-consuming and expensive, and generates too large data. Furthermore the outcome of digital reconstructions is frequently provided in non-interoperable formats, and not easily accessible too. The European Project "INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic modelling", funded by EC within the Programme Horizon 2020, proposes the enhancement of efficiency in 3D data capturing procedures and devices.

1. INTRODUCTION

The greatly stimulating effect of technological innovation as the speed of the digital image processing could mislead and it is easy to make confusion between purposes and actions while dealing with enhancement and promotion of cultural heritage. This phenomenon threatens to generate substantial disaffection among specialists and technicians who seek to give some useful validity to their subject matter through description.

The nearly ten years of research and experimentation have been characterized by an attempt to focus efforts and contribute to the enrichment of representational knowledge of existing elements. The chosen research field, which nevertheless remains open to interdisciplinary approaches, is surveying, representing and preserving our cultural heritage. The newly developed technologies for the automatic acquisition of geometrical data are innovative elements that allow us to create databases of high definition, three-dimensional morphometric data.

These archives of architectural and archaeological data are a valuable research tool for archaeologists, architects, and historians of art and architecture, but also, and above all, they serve the purpose of protecting and preserving cultural heritage sites and provide support to restoration processes and training programmes.

The development of criteria for multilevel organization of databases are mainly oriented to preservation and restoration work, but also contributes to the enhancement, promotion, management, and enjoyment of cultural heritage sites. The database contains 3D models obtained by the use of laser scanner and all the topographic, photographic, diagnostic, and structural data associated with them. Databases allow users to consult and update all data, providing an important foundation for the management, preservation, maintenance, and enhancement of heritage sites.

The European Project “INCEPTION - Inclusive Cultural Heritage in Europe through 3D semantic modelling”, funded by EC within the Programme Horizon 2020,aims to solve the shortcomings of state-of-the-art 3D reconstruction by significantly enhancing the functionalities, capabilities and cost-effectiveness of instruments and deployment procedures for 3D laser survey, data acquisition and processing. It solves the accuracy and efficiency of 3D capturing by integrating Geospatial Information, Global and Indoor Positioning Systems both through hardware interfaces as well as software algorithms.

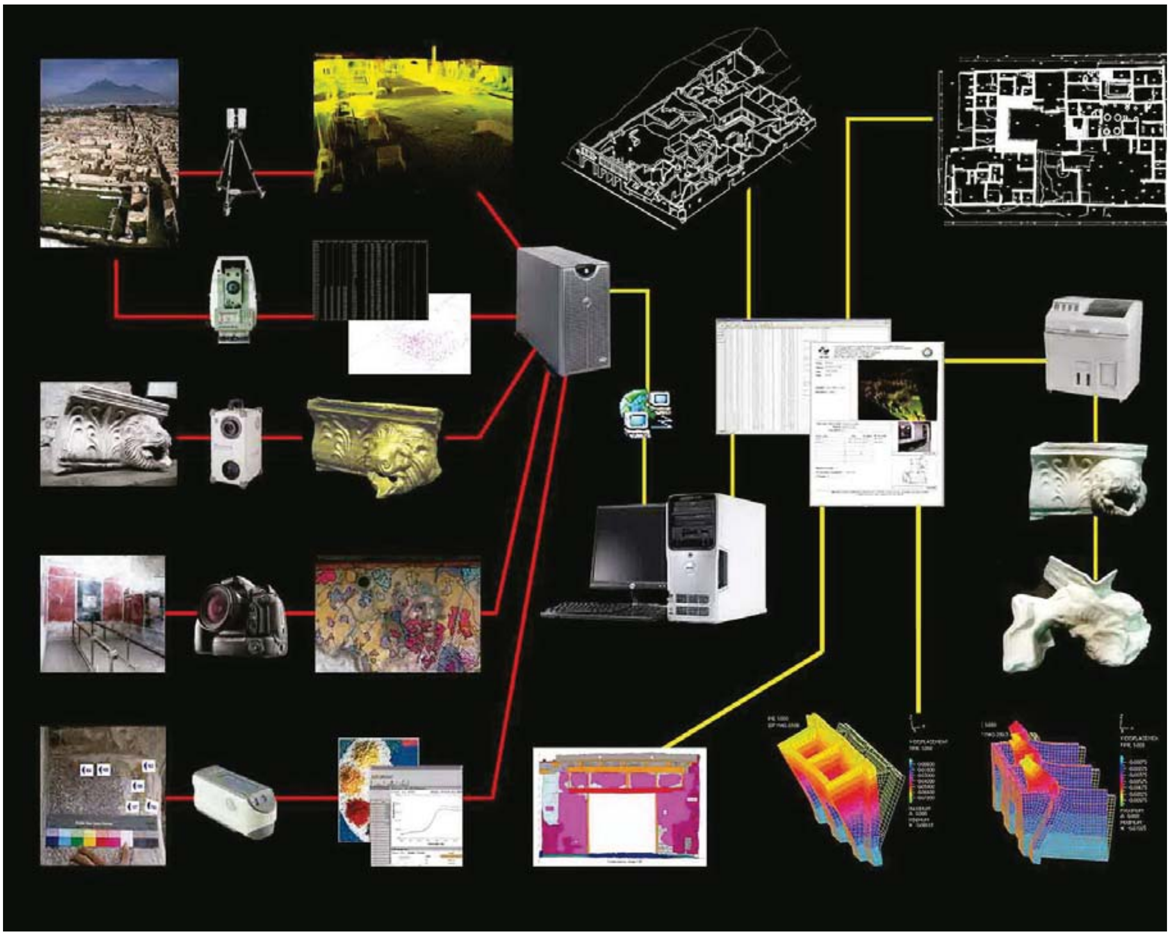

Fig1. 3D integrated survey methodologies applied to the Pompeii archaeological site: 3D time of flight laser scanner survey, topographic survey, 3D optical triangulation laser scanner, digital photographic surveyare integrated to analysis of conservative specifications by spectrophotometric surveyandreflectivity index. It is possible to obtain CAD representations, solid models by 3D printer, structural analysisand conservative specifications.

2. STATE OF THE ART

Nowadays a wide range of devices and technologies for 3D data capturing are available, and these technologies are more and more accurate and fast. High quality 3D acquisitions are now possible even with low-cost devices and freeware tools, but every 3D measurement device present different limitations and potentialities, requirements and specifications, characteristics that must be carefully assessed in order to correctly carry out a survey.

An integrated tridimensional survey, aimed at metric, morphological and diagnostic measurement, has a complex and hierarchical data structure, in which every registered value contributes, by its specific properties and different capturing processes and techniques, to the creation of a metric descriptive model. The most accurate survey methodologies and processes involves several phases and devices in order to perform on-site data acquisition, data processing (scan registration, data cleaning, surface reconstruction, texturing, etc.), outcomes and drawings production based on specific purposes.

By this, multi-scale and multi-purposes analysis of an artefact, based on its context, could be carried out.

Moreover, some gaps in the procedure of 3D acquisition and data management still occur due to the lack of technological integration between different kind of devices and instruments and because the huge amount of acquired data very often requires time consuming processes.

Fig 2. Cross section directly obtained from the point cloud model generated by the 3D integrated survey. The amount of information acquired, opportunely normalized (such as density and reflectivity index) allows analysis and direct interaction with the architecture, avoiding additional representation procedures. This acquisition-visualization method allows a high level of knowledge and usability of two-dimensional drawings reducing time and cost.

The INCEPTION project[1] will face the changing role of 3D digital models in heritage representationand theircollaborative use across disciplines.Breakingdownthe barriers caused by

[1] The project, started in June 2015, will be developed by a consortium of fourteen partners from ten European countries led by the Department of Architecture of the University of Ferrara (scientific coordinator Prof. Roberto Di Giulio) which makes use of the facilities and researchers of the Laboratory TekneHub, Ferrara Technopole, belonging to the Construction Platform of the Emilia-Romagna High Technology Network. Academic partners of the Consortium, in addition to the Department of Architecture of the University of Ferrara, include the University of Ljubljana (Slovenia), the National Technical University of Athens (Greece), the Cyprus University of Technology (Cyprus), the University of Zagreb (Croatia), the research centersConsorzioFuturo in Ricerca (Italy) and Cartif (Spain). The clustering of small medium enterprises includes: DEMO Consultants BV (The Netherlands), 3L Architects (Germany), Nemoris (Italy), RDF (Bulgaria), 13BIS Consulting (France), Z + F (Germany), Vision and Business Consultants (Greece).

The project has been applied for the Work Programme Europe in a changing world – inclusive, innovative and reflective Societies (Call - Reflective Societies: Cultural Heritage and European Identities, Reflective-7-2014, Advanced 3D modelling for accessing and understanding European cultural assets).

the sector segmentation, a ‘common framework’ for the interpretation of European cultural identity and diversity through 3D documentation of cultural heritage sites and buildings will be established.

3. THE INCEPTION METHODOLOGY

The INCEPTION main aim is focused on innovation in 3D modelling of cultural heritage through an inclusive approach for time-dynamic 3D reconstruction of heritage sites and on the possibility to create an inclusive understanding of European cultural identity and diversity by stimulating and facilitating collaborations across disciplines, technologies and sectors.

Within this overall framework, the project will develop cost-effective procedures and enhancements for on-site 3D survey and reconstruction of cultural heritage artefacts, buildings, sites and social environments.

This objective will be achieved by:

- Enhancing the efficiency of three-dimensional data capturing procedures and devices, especially their suitability and aptitude for the physical cultural resources and assets: cultural heritage sites, historical architectures, archaeological sites and artefacts that are characterized by smart handling of non-conventional characteristics, location and geometries.
- Developing new methods for condition assessment survey of cultural heritage which are based on predictive analysis (diagnostic, conservative, morphometric), non-destructive procedures and supported by economically sustainable technologies and devices.
- Optimization of hardware and software instruments for easy scan system, rapid capture of main features/geometric data, and automated data output in an H-BIM environment.

The integrated data capturing methodology will be accomplished by the implementation of a common protocol for data capturing and related enhancement of functionalities, capabilities and cost-effectiveness of data-capturing technologies and documentation instruments. The protocol will consider quality indicators, time-consumption, cost-effectiveness, results accuracy and reliability, useful data to be recorded for heritage applications.

In order to maximize the impact, the INCEPTION project will adopt a broad and a dedicated Stakeholder Panel, in order to provide a significant panel discussion with experts in the field of Cultural Heritage not only scientifically but also directing research toward those strategies needed by "end users" and institutions to increase knowledge, enhancement and dissemination through digital models in order to promote the inclusiveness and accessibility of European cultural heritage. The members of the dedicated Stakeholder Panel will provide demonstration cases, support the consortium in data collection, and exhibit the preliminary results of the project through either on-site or off-site demonstration activities.

An innovative concept for an enhanced 3D data capturing system, addressed to an easier and more accessible data processing and modelling, will be developed: experimentation for an enhanced 3D data capturing system equipped with a new firmware optimized for cultural heritage application, addressed to an easier and more accessible data processing and modelling, will be accomplished putting in action the protocol during the survey procedures of the demonstration cases.

The development of tools for 3D automatic delineation depending on acquisition technologies, from point clouds to photo-based data, will allow to achieve a common standard interoperable output for BIM environment.

Fig 3.Tempio di San Sebastiano, Leon Battista Alberti, Mantua. Overlap between the point cloud obtained by means of 3D morphometric acquisition and its graphic rendering through BIM parametric modelling, and, in particular, Heritage-BIM environment

3.1. Optimization of 3D data acquisition protocol

Starting from the state-of-the-art concerning main 3D survey methodologies and documentation systems and recording 3D (data capturing mobile devices, drones and aerial survey devices, mobile robots) the project will develop an integrated methodology and protocol for Cultural Heritage acquisition. The main purposes of data acquisition protocol are:

- close the gap between specialist technicians and non-technical users involved in heritage documentation, in order to facilitate non-technical users;
- provides a guide to the user and the supplier of metric survey data, explaining expected features in order to achieve the main goals in cultural heritage documentation and data capturing;
- definition of common procedure for historical data retrieval and possible previous survey; cataloguing and digitization; knowledge of geometric, surface and structural features; analysis of the state of conservation; maintenance of programmatic interventions in the short and long term;
- list of performance indicators to ensure the effective management of metric survey projects, focusing on the needs and requirements of non-technical users of heritage documentation;
- examines issues such as quality, accuracy, time, costs and specific skills required - focus on needs to be developed regarding data precision and 3D accuracy, visualization production systems, etc.

The project will develop a framework for LIDAR data capturing with very high documental value, based on the enhancement of current systems, by specific adaption of the firmware to optimized 3D data acquisition protocols and standards for Cultural Heritage documentation.

The enhancements will focus on firmware level and consider such as selection modes, basic data segmentation (e.g. object from context), filtering (e.g. moving objects as site visitors), data preview functions (e.g. integrity check), data density control (e.g. thresholds for meshing), registration assistance (e.g. overlap indications). The data communication workflow will be adapted to analysis results and dedicated processing routines in the Cultural Heritage context.

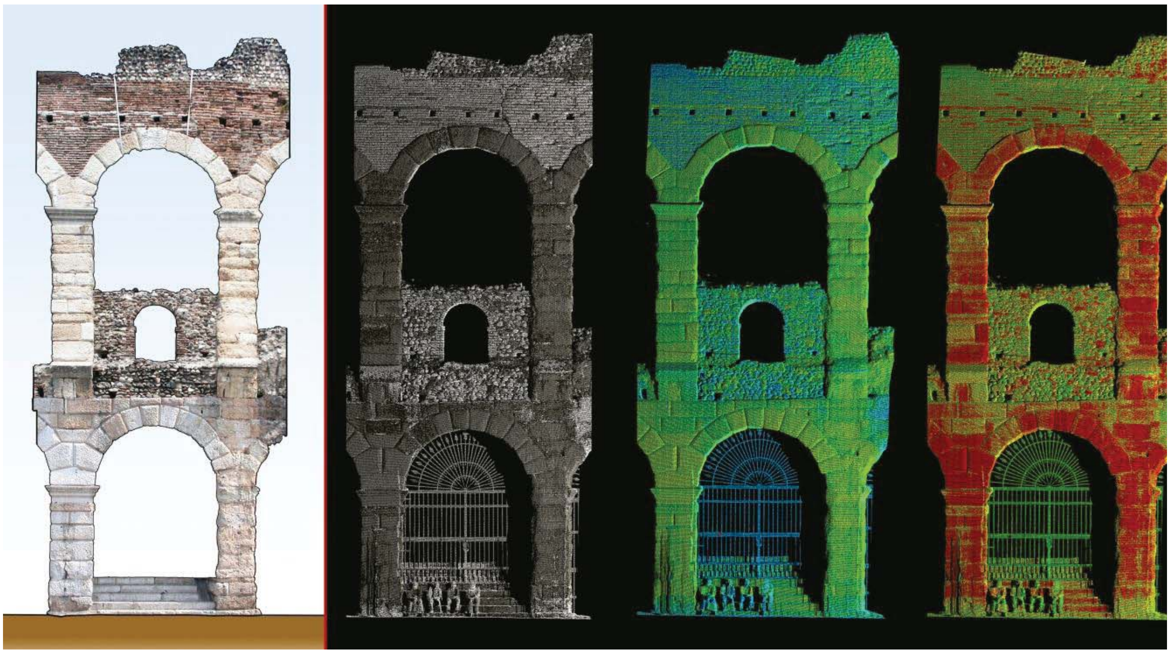

Fig 4. Arena di Verona. Digital image process starting from the data obtained by the 3D laser scanner survey, time-of-flight technology. The processing of the reflectivity index for the identification and analysis of the homogeneous surface' areas (in order to analyze the state of conservation of historical surfaces) and the orthogonal elevation obtained by photos colorimetrically calibrated are useful tools for the analysis of surfaces' conditions and historical materials

4. 3D DATA MODELLING: FROM THE POINT CLOUD TO THE BIM ENVIRONMENT

As well as three-dimensional scanners are a technology now widely used in the field of cultural heritage survey and the field of restoration and conservation, the Building Information Modelling systems, starting from the development of CAD, are becoming tools more and more used for the documentation of cultural heritage, as well as semantic web technologies.

The integration between BIM environments and three-dimensional acquisition technologies is one of the challenge to be faced in order to guarantee a truly collaborative process in the heritage preservation sector.

Starting from the implementation of the 3D data capturing protocol for heritage applications and the identification of the Cultural Heritage buildings semantic ontology and data structure for information catalogue, the project will develop guidelines for 3D parametric and semantic modelling in an Heritage-BIM environment, based on Open BIM standard, improving a "BIM approach" for Cultural Heritage.

3D models generated through INCEPTION methods and tools will be accessible for many different users. Semantic enrichment will generate 3D models for multiple purposes depending on the needs and level of knowledge of the end-users. The semantic enrichment will link geometric information for 3D visualisation, historical information, and geo-technical data as well as structural information for material conservation, maintenance and refurbishment.

An open-standard format and semantic ontology to generate high-quality, reliable and interoperable models of H-BIM will be used in order to manage point clouds in the overall process to generate 3D models without compromising the high quality and accuracy of surveyed data.

Semantic H-BIM allows users not only to access but also to interact with the models, allowing spatial and multi-criteria queries in a virtual 3D environment. The end-users will be able to access information utilising a standard browser, and they will be able to query the database using keywords and an easy search method.

INCEPTION semantic modelling approach will resolve the existing barriers between data collection and documentation, as well as between model creation and analysis / interpretation.

5. CONCLUSION

The need of a future re-use of such broad and descriptive source of measurement data demands new applications to facilitate information accessing collected in three-dimensional database without compromising the quality and amount of information captured in the survey.

Databases allow users to understand how each survey-phase was carried out (scans, topographic support, images acquisition, etc.) and thus to obtain the maximum possible amount of morphological information; this procedure means to work with complex interfaces that are based on the programming languages of the software used to complete the survey itself.

Currently, efforts in developing the user interface are concentrated on providing direct or partially controlled access to the large three-dimensional scale models, also by means of immersive navigation. The creation of large digital spaces properly set up in terms of both form and dimensions, will make possible to navigate, enter, and extract its qualities and specifications (measurements, colors, materials, historical documentation, conservation records) in real time.

However, the user's needs and desire for knowledge might be somewhat stymied by such complicated interfaces that could be hard to understand.

Current efforts are focused on creating immersive and easy-to-use 3D visualizations that can be accessed from a wide range of user.

The field of experimentation underlying the integrated, interdisciplinary research effort shares many aspects (dimension and complexity of the data) with heritage surveys, and the results obtained so far give us reason to hope that these optimization processes can be exported.

New simplified navigation interfaces are also being developed for users with lower levels of expertise to facilitate access to and navigation of the three-dimensional models.

It is thus clear that new visualization and communication modes for the geometrical and measurement information have to be conceived and developed in step with the development and application of three-dimensional surveys.

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Risks and Resilience of Cultural Heritage Assets

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Abstract. The heritage assets are permanently exposed to natural and anthropogenic hazards. The risk analysis which are the among the most important tools needed for decision making in process of cultural heritage asset management and maintenance is quantitative and qualitative. The qualitative part is in case of heritage assets more demanding than quantitative. However, the basic questions are related to prediction of type of harmful event, likeliness of its appearance and prediction of its consequences. In this process is important to identify the potential risks for heritage asset under observation and capacity of asset to resist the potential harmful impacts. The starting point of activities in process of sustainable protection of cultural heritage asset is collecting of as much as possible complete set of data where the use of contemporary and emerging ICT tools is unavoidable. In the present paper the contributions of recently completed FP7 projects Climate for Culture and EU CHIC as well as ongoing H2020 project INCEPTION will be presented and highlighted in context of risks and sustainable protection of cultural heritage assets. Both the problem of objects and buildings will be addressed and protocols for data collecting developed in above named FP7 projects will be described.

Keywords: cultural heritage, risks, resilience, data collection protocol, 3D digital documentation

1. INTRODUCTION

The European and Mediterranean built heritage is endangered by environmental impacts that are becoming more and more severe due to climatic changes. However, the additional serious threat to heritage is simply lack of knowledge of subjects that are engaged in its safeguarding even on the basic level of relatively simple but extensive interventions in building structure and fabrics. In September 2009, the 36 months European Coordinated Action entitled European Cultural Heritage Identity Card was launched. Its main intention was to establish the Pan-European approach to collection and evaluation of data on cultural heritage assets in order to facilitate the increase of knowledge on the heritage building stock across Europe. It is needed as a support of sustainable maintenance and preservation and revitalization of historic sites and monuments in general. The concept of the Identity Card of heritage buildings and monuments is description and classification system for data collection on current state of asset including available data about the asset changes over time. It is essential for development of the management, conservation and maintenance strategies.

In many countries there are well-established systems and tools used for inventory and documentation of the cultural heritage. The tradition in care for cultural heritage reflects in them and the local approaches and understandings are basis for their approach to content. In some countries there are several systems for data collection, which are not connected together. Therefore, the strait comparison of data on heritage assets is not possible. The overview of currently used approaches in seven countries (Croatia, Czech Republic, Greece, Israel, Italy, Poland and Slovenia) was presented during the 1st EU-CHIC Workshop held in Vienna on April 29 2010 (Žarnić et al., 2012). However, the Ad hoc group for Inventory and Documentation within the Technical Co-operation and Consultancy Programme related to the Integrated Conservation of the Cultural Heritage contributed the most complete effort in harmonization of approaches on at least basic level in form of three standards related to historic buildings, monuments, archaeological sites and heritage objects (Guidance, 2009).

The idea of Identity Card originates from the COST Action C5: "Urban Heritage-Building Maintenance", 1996-2000 (Hofmann et al., 2002). The general conclusion stressed in final report was that there is a serious lack of reliable data on European urban heritage and a pressing need to collect it, in order to support the on-going process of refurbishment of existing buildings. COST C5 Action concluded that there are great variations in the systems of establishing and evaluating data from buildings in the European countries. The responsibility for collecting data depends on the administrative structure in each country. Planning of broad activities, such as preventive strengthening or even post-earthquake measures in European earthquake prone areas, or energy preservation measures, can be better based on mutually developed methodology. The basic rules and approach can be developed from the existing European standards and codes. However, no generally accepted approach existed that would lead to European methodology.

The creation of Pan-European protocol for data collection is just a first step in the more ambitious process. The essential part of data in this protocol is related to identification of risks to which heritage assets are exposed. It is well known that the vulnerability of assets is one of main criteria for intervention in asset in order to increase its resilience. The final aim of process is to develop a general approach to resilience assessment of heritage assets based on identification of risks that can be generalized by introduction of risk indicators.

2. THE CULTURAL HERITAGE IDENTITY CARD

The main objective of the Coordinated Action EU-CHIC (www.eu-chic.eu) was to develop and test guidelines that are required for the efficient compilation and storage of data pertinent to each asset under observation. The current trends in heritage preservation are oriented to sustainable maintenance, preventive conservation, and rehabilitation of historic sites and monuments. They also include newly developed strategies of efficiency evaluation, and creation of user-friendly methodologies for screening of time varying changes to heritage buildings as a result of human intervention and environmental impact. The basis of all above mentioned activities and approaches is wide knowledge about heritage assets that can be obtained only by systematic collection and proper processing of data. Data can be collected and well maintained only if the appropriate protocols are developed and applied. In figure 1 the main purpose for establishing of documentation protocol is briefly illustrated.

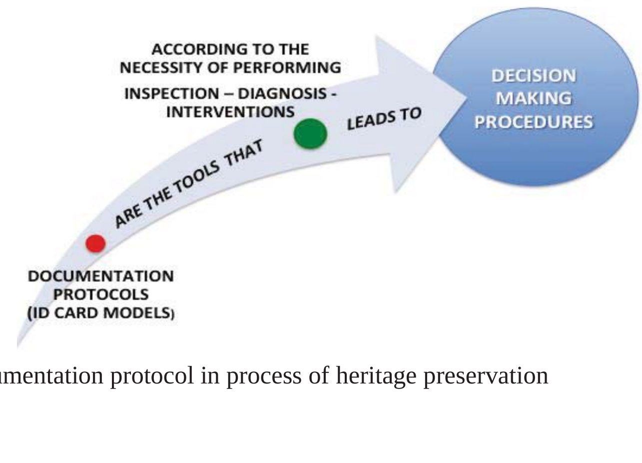


Fig 1: The role of documentation protocol in process of heritage preservation

The documentation protocol can be understood as an envelope with set of rules, which establish and define the categories of data needed for achievement of targeted goal. If protocol is set in general way, it can be used for collection and processing of different types of data. In case of protocol for cultural heritage it can be applied to build heritage, to archaeological sites, to cultural landscape, to heritage objects and to collections of artefacts. Protocol can be composed of several layers regarding the type of data their amount and nature. During their lifetime the heritage assets have been constantly exposed to external natural influences that caused the material and structure decay processes and to alternations of use and interventions in their structure. The necessary data for evaluation of consequences of events in assets lifetime can be collected from different sources and documents but the on-site inspection is the only way to assess the current state of asset. From assessment of asset under observation and knowledge gained from studying of similar cases the prediction of future behaviour can be estimated. The important data for estimation, besides ones collected by inspection, are risks of events that may happen in future life of asset. The sufficient amount and reliability of data is necessary background for decision-making that determines and thus influence the future life of asset. Those who are responsible for asset should always be ready to answer to the simple question: "What will be the consequences of their decisions?"

The collecting of detailed data on cultural heritage assets engage a significant amount of efforts of professionals and researchers what means also engagement of significant amount of funds. Therefore, the owners or responsible organization of authority has a property rights and can exploit data following their needs. However, a certain amount of data should be given to the interested public for general use (research, education, tourism etc.). On other side, the sensitive data that are under owners' control are needed for management and all other decisions related to ownership of asset.

As an answer to these dilemmas, the new structure of data has been developed. It was visualized in form of iceberg and named "Chicberg" (figure 2).

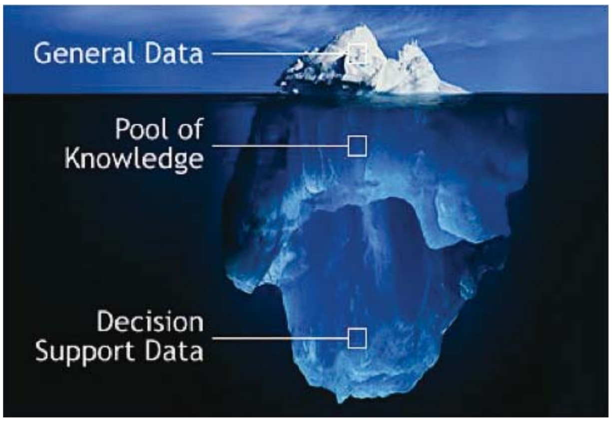


Fig 2: The "Chicberg" scheme of data organization

Table 1: Data categories in the "Chicberg" scheme

General Data: Basic information o cultural heritage asset			
Name, location, legal status, type, dating, function, major risks, materials, structure, state of conservation			
Pool of Knowledge: Detailed Information on the Cultural Heritage Asset			
Non-physical Aspects		Physical Aspects	
History	Legal issues	Geospatial aspects	Structure
Art history	Economical issues	Risks	Movable objects
Sociology	Previous interventions	Archaeology	Current condition
Ethnology	Conservation	Architecture	Energy efficiency
Cultural landscape	Valuation methods	Materials	Surveying techniques
Decision Support: Knowledge implementation procedures			
Intervention decision making			
Decision impact analysis			
Site management			

Data, that in their total volume create the Identity Card, are divided in two groups (table 1). The "upper" group of data are open to general, public use. The "lower" two groups of data are the sensible ones and of high value for owner of asset. Therefore, they can be used only upon their permission.

Following this scheme, the Cultural Heritage Identity Card is not a single document of asset but a set of documents that contains comprehensive information and that are created and updated due entire lifetime of asset. The updating follows the changes of asset after the initial creating of files. Therefore, the system of three levels is established as presented in table 1. The first level of the Card contains data collected mainly from publically available sources with additional information about current physical condition and major risks to which asset may be exposed. The original intention of the Card was to establish a system that will enable comparison between the assets of same type across the Europe and Mediterranean countries. The first level of the Card is designed to meet this goal.

When designing the first level of card the existing national and international systems were carefully studied to include some of their parts into it. Ad hoc Group for inventory and documentation within the Technical Co-operation and Consultancy Programme within the Council of Europe has developed the most comparable system that is divided in three internationally agreed standards for the documentation of the cultural heritage: "Core Data Index to Historic Buildings and Monuments of the Architectural Heritage", "International Core Data Standard for Archaeological Sites and Monuments" and "Object ID" (http://archives.icom.museum/object-id/heritage).

The standards form an important, well-established system and the intention of EU CHIC is not to compete or replace it but to integrate them to wider and more ambitious system. The first level of the Card is meant as an introduction to lower, more important levels because the basic information about asset given in the first level is elaborated in detail in the second level named Pool of Knowledge. The structured knowledge, as presented in table 1, is a basis for the most important aim of system: support to decision making that is of crucial importance for preservation of cultural heritage asset. One of most important issues is prevention of heritage asset from the risks. Risks can be identified from past events in area of heritage asset location but also from the scientific prediction of potential harmful events. The variety of risks and concurrency of events can be managed by introduction of risk indicators that enable good prediction of influences even when the amount of reliable data is not sufficient. Using data collected at the second level, the resilience of heritage asset can be assessed as explained in next chapter of this paper.

3. RISK, VULNERABILITY AND RESILIENCE OF HERITAGE ASSETS

3.1 Risk and resilience in general

The concepts of vulnerability, resilience and risk are relatively well established in many disciplines related to environment and its protection. Some of these elements can be used in the domain of cultural heritage preservation. What is missing is an action that will gather the existing knowledge, contribute to existing knowledge with concrete tools for quantification of risk indicators, promote their application, and communicate the outcomes through workshops and conferences.

The research networking within the group of experts will further upgrade the Cultural Heritage Identity Card by widening the aspects of risks and development of common resilience models of built cultural heritage. Its development will continue in the HORIZON 2020 project INCEPTION (www.inception-project.eu), where several partners of EU CHIC projects are involved.

Because of vast number of built heritage assets across Europe, it is fairly impossible to cover all assets. This issue can be addressed to a certain extent through development of risk indicators, which requires clear rules and protocols for collecting and managing data on various types of heritage assets and related risks. Referring to the OECD approach to measurement, a risk indicator is an indicator that captures the potential for some form of resource degradation using mathematical formulas. Risk indicators are particularly useful as they reduce the number of parameters that would otherwise be needed to reflect the actual situation. To communicate clearly with concerned stakeholders, the pertinence of risk for heritage, the scope of a selected indicator set and the level of detail need to be limited. Otherwise, an extensively broad set would clutter the specific information it is meant to provide. In their interpretation, the risk indicators need to lend themselves to unambiguous division into combining parts. Such decomposition into subcomponents of a risk indicator is necessary to understand the impact of underlying factors on the aggregate picture that a risk indicator presents. Due to their adaptation to user needs for the right information for the right purpose, indicators may not necessarily meet strict scientific demands to demonstrate causal links. Risk indicators rather highlight key trends and correlation patterns that provide basis for further research based on appropriate mathematical models to establish causal relationships.

In general, the selection of risk indicators will ideally need to be based on clearly defined general and specific criteria. Generally speaking, the risk indicators will need to be relevant for informing about the resilience of heritage to pressures induced by humans and nature. Specific risk-heritage links will also need to be measurable and quantifiable by accurate and timely data, which are available at a reasonable cost. The analytical soundness of the methodology to construct indicators is of essence here.

Another set of specific criteria is required to reflect the vulnerability and resilience aspects in relation to cultural heritage assets, defined as follows:

- Risk indicator is an indicator that estimates the potential for some form of heritage asset degradation using mathematical models.
- Vulnerability of heritage asset is a measure of the extent to which it is likely to be damaged due to the location, nature or the impact of a particular disaster hazard.
- Resilience of heritage asset is its technical capacity to respond with resilience to external perturbations and changes or to a particular disaster hazard.

The proposed unified approach to monitoring risks to cultural heritage will also allow scientifically based prioritization of interventions. Currently, the selection of most needed actions is difficult because relevant data are scattered across countries, there is lack of clearly defined criteria, and shortage of available funds for individual initiatives in countries. The countries partnering in the INCEPTION project will therefore benefit from the access to the proposed system for identification of risks to heritage assets. It will provide them with the opportunity to apply the proposed set of indicators in planning of maintenance and preventive conservation activities.

Table 2: Major risks to which are heritage assets exposed

Environmental risks			
Long term influences		Sudden events	
Bio attack	Solar radiation	Wind-storm	Landslide
Climate conditions fluctuations	Particle matter and aerosols	Fire	Avalanche
Aeolic impact	Long term influences	Flood	Tsunami
Water impact (ground, atmospheric)	Geological conditions (global, local)	Earthquake	Volcano

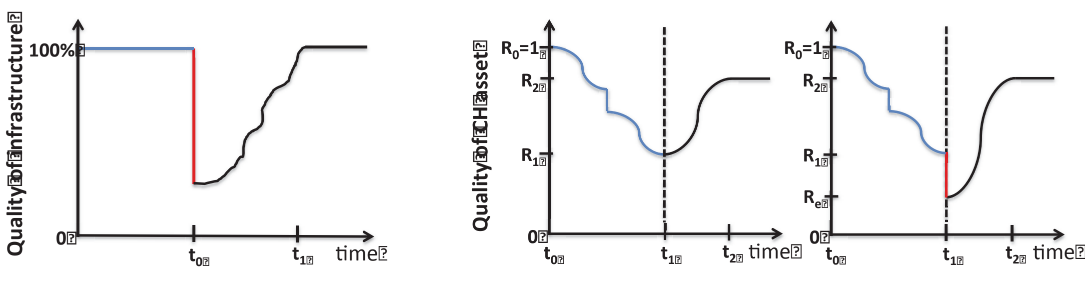
Anthropogenic - social risks	
Unintentional influences	Intentional events
Economic activities	Vandalism
Accidents	Riots
Improper decisions	Wars

Major risks that affects the asset, as identified within the EU CHIC project, are presented in table 2 above. Long-term environmental impact is expressed in term of the environmental factors, which affect the asset and the results appeared after a long period of time. Sudden environmental impacts are expressed in terms of events which affect the asset and which time of occurrence could not be foreseen in advance. Anthropogenic impacts that might be the consequence of regular economic activities and other unintended sources of harmful influence to heritage asset or the consequence of intended harmful influences. Among the most dangerous are the improper decisions of those who are responsible for management of asset.

3.2 Resilience model for heritage assets

The concept of resilience is developed in domain of earthquake engineering, but earthquake is only one of sudden environmental impacts that endanger heritage buildings. However, the knowledge developed in this area can be transferred and enlarged to all other risks to which heritage assets are exposed. As part of the conceptualization of a framework to enhance the seismic resilience of communities in USA (Bruneau, M. et al., 2003), seismic resilience has been in 2003 defined as the ability of a system to reduce the chances of a shock, to absorb such a shock if it occurs (abrupt reduction of performance) and to recover quickly after a shock (re-establish normal performance). More specifically, a resilient system is one that shows:

- Reduced failure probabilities,
- Reduced consequences from failures, in terms of lives lost, damage, and negative economic and social consequences,
- Reduced time to recovery (restoration of a specific system or set of systems to their "normal" level of functional performance)



(a) (b) (c)

Fig 3:Resilience model (a) proposed by Bruneau M. et al., 2000 and resilience model of cultural heritage asset in the case of long term (a) and in the case of sudden (b) environmental or/and anthropogenic-social impacts (proposed by authors of this paper)

A broad measure of resilience that captures these key features can be mathematically expressed and thus calculated. Resilience depends on the quality of the asset. Specifically, performance can range from 0% to 100%, where 100% means no degradation in quality and 0% means total loss. If an earthquake or other disastrous event that occurs in short time period, it could cause sufficient damage to the asset such that the quality measure is immediately reduced (from 100% to 50%, or in the worst case of collapse to 0%). Restoration of the asset is expected to occur over time it is completely repaired and functional (indicated by a quality of 100%).

When the resilience of existing, contemporary infrastructure endangered by earthquakes is observed (figure 3a), the basic assumption is that the infrastructure is 100% resilient in time of occurrence (t_0) of earthquake and that the same resilience can be restored by appropriate intervention in certain time period (t_1).

The assumption of here proposed resilience model for cultural heritage assets (figure 3b and 3c) is different because of the specific nature of cultural heritage asset. It was 100% ($R_0 = 1$) resilient in time of its creation. Various long-term and sudden impacts occurred during its lifetime that is measured by centuries or even millenniums. In present time (t_1) in figure 3b, is the resilience of asset much lower than the initial one ($R_1<R_0$). It practically cannot be completely restored to its original state but only to best achievable ones ($R_1<R_2<R_0$). Theoretically it would be possible to reach the initial resilience (R_0) only in cases, when the complete documentation of the initial state would be available. Documentation is complete only if contains both, data on tangible characteristics and intangible values of asset. The solution of problem becomes even more demanding if in observed, present time (t_1) in figure 3c the additional sudden drop (R_e) of resilience occurs during the natural or anthropogenic-social impact.

Extended research is needed to quantify resilience, particularly for some type of critical assets. For critical assets for which the deliverable is not a simple engineering unit, such as for the case of heritage endangered by anthropogenic threats the quantification is almost impossible. However, it is worthwhile to start research in this area, which is completely new, and the future progress and outcomes are not very much predictable.

Resilience for both physical and social systems can be further defined as consisting of the following properties (Bruneau M. et al., 2003):

- Robustness: strength, or the ability of elements, systems, and other measures of analysis to withstand a given level of stress or demand without suffering degradation or loss of function.
- Redundancy: the extent to which elements, systems, or other measures of analysis exist that are substitutable, i.e., capable of satisfying functional requirements in the event of disruption, degradation, or loss of functionality.
- Resourcefulness: the capacity to identify problems, establish priorities, and mobilize resources when conditions exist that threatens to disrupt some element, system, or other measures of analysis. Resourcefulness can be further conceptualized as consisting of the ability to apply material (i.e., monetary, physical, technological, and informational) and human resources in the process of recovery to meet established priorities and achieve goals.
- Rapidity: the capacity to meet priorities and achieve goals in a timely manner in order to contain losses, recover functionality and avoid future disruption.

In the specific cases of heritage assets additional properties should be identified.

3.3 Resilience and risk indicators

The basic idea of further research in cultural heritage domain is to apply theory of resilience for development of efficient measures for preservation of cultural heritage assets. It is obvious that for each type of environmental or anthropogenic impact the mathematical models of resilience should be developed but, all will emerge from the above explained platform (figure 3). The main problem is not in mathematical formulation of model but in reliable and realistic input data for calculation of resilience. In case of heritage asset that is exposed to several different categories of impacts, the total resilience is a combination of partial resiliencies associated with every relevant impact. And as mentioned above, the earthquake is only one of them.

The use of the risk indicators for definition and, where it is possible, quantification of input parameters for resilience assessment is crucial for practical application of resilience model. In principle, indicators can serve many purposes depending on the level at which they are applied, on the audience to be reached, and on the quality of the underlying data sets.

A key function of indicators is to simplify the communication process by which the results of analysis and accounting are provided to the users and to adapt information to their needs. The indicators need to be communicated in a way that is understandable and meaningful by reducing the complexity and level of detail of the original data. Due to this simplification and adaptation, the indicators may not always meet strict scientific demands to demonstrate causal chains. They rather represent trade-offs between their relevance for users and policies, their statistical quality and their analytical soundness and scientific coherence. Indicators therefore need to be embedded in larger information systems – such as databases, accounts, monitoring systems and models.

Although some of these categories of risks as presented in table 2 above can be quantified, such as earthquake risk, there is no generally accepted measurement framework that would permit standardized description, harmonized monitoring, and analytically sound quantification of risks to built heritage assets. However, an additional risk to those ones presented in table 2 should be mentioned - a risk of deteriorating processes in materials and structures relate to external influences or internal chemical and/or physical time-depending variations of material characteristics. A dashboard of risk and resilience indicators would facilitate prediction of the long-term natural impacts and management of anthropogenic factors.

4. CONCLUSIONS

In current era of rapid development of ICT their application in heritage preservation domain is not yet sufficient. However, the international interest for using of ICT tools in traditionally and by its nature conservative discipline is growing. Very positive move in this direction has been achieved during the International Conferences on Cultural Heritage and Digital Libraries EUROMED 10, 12 and 14 (www.euromed2012.eu and www.euromed2014.eu) where the large area of possibilities and already developed technologies and applications in cultural heritage domain were presented. The architecture of EU CHIC is opened for further upgrading what gives opportunity for rising of its quality by wide application of ICT. But the main role of ICT will be in providing data and models for resilience assessment using the risk indicators. As stressed earlier, the quality and quantity of reliable documentation is crucial for restoring of resilience of heritage assets. Important part of documentation is visualization of asset as whole and its parts including details that may have a crucial importance in restoring of monuments and historic buildings. The long-term preservation of data is another crucial issue that has to be still addressed on proper way. The current storage media may not be sufficiently durable and resistant to various influences. Therefore, new media should be developed and become available in order to assure long-term preservation of stored data. The ongoing H2020 project INCEPTION will contribute to the development of resilience models by extensive development of crucial ICT tools.

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The Contribution of GIS for the Sustainable Protection of Monuments: The Case of Erimokastro and Earantapixo Acropolis in Rhodes, Greece

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Abstract. The use of GIS (Geographic Information System) as a tool for the analysis of all the diverse data gathered from a monument is of great importance. Through a GIS platform, the process of characterizing and classifying data, as well as their connection to various descriptive data is presented. The descriptive data consist of historical, architectural, structural documentation, material and decay patterns data, photographs, conservation interventions documentation, cost analysis data etc. Within the framework of the preservation of built cultural heritage, the utilization of GIS, monitoring the pathology and preservation state of a monument, contributes to decision making and planning of conservation interventions and rehabilitation of the area under study. In this paper, the process of the gathering and representing data from multidisciplinary studies through a GIS platform and the elaboration of thematic maps of the buildings pathology and conservation interventions in two cases, are presented, the case of Acropolis of Erimokastro in Rhodes Island and the case Acropolis of Sarantapixo in Rhodes In conclusion, through the utilization of GIS in monuments, a dynamic multidisciplinary database is created, which can lead to its further management and conservation

1. INTRODUCTION

In this paper, the process of the gathering and representing data from multidisciplinary studies through a GIS (Geographic Information System) platform and the elaboration of thematic maps of the buildings pathology and conservation interventions are presented. In general, the monitoring and preservation of heritage monuments is based on various kinds of investigations and analytical data. Investigations are carried out in order to diagnose the monuments current state of conservation and future restoration interventions. In the work described, a multidisciplinary approach was applied for the damage rehabilitation of the archaeological site of Erimokastro Acropolis and Sarantapixo Acropolis in Rhodes, Greece. The Acropolis of Erimokastro (Deserted Castle) is an established archaeological site, located upon a natural hill between Kallithea and Afantou bays. Its dry-stone walls are multifaceted and possibly of cyclopean type ‘figure 1’. The Acropolis of Sarantapixo is not an established archaeological site, even though there is strong evidence that it was protected by cyclopean walls of the Mycenaean period, and their remains are still evident throughout the site. It is situated in the northeastern part of Rhodes ‘figure 2’.

Fig1: The Entrance of Erimokastro Acropolis

Fig 2: The Wall of the Sarantapixo Acropolis

2. DOCUMENTATION

In the Acropolis of Erimokastro and the Arcopolis of Sarantapixo, selected facades were depicted for the documentation. This approach included: (a) a combination of close range photogrammetric and field survey techniques, and (b) the characterization of building materials and decay diagnosis, using nondestructive techniques in situ and analytical techniques in the laboratory, after sampling. The collected data were incorporated into a GIS platform creating a relational database. The ortho-rectified images ‘figure 1’, ‘figure 2’ were used as the GIS base-map, where data elements in space were recorded. The diagnostic study results comprised the information data about building materials and decay patterns. GIS thematic maps of building material and decay patterns were elaborated, presenting characteristic parts of Erimokastro Acropolis and Sarantapixo Acropolis.

The geometric documentation was accomplished with the use of terrestrial measurements and the use of photogrammetric methods in both archaeological sites, providing the necessary qualitative and quantitative information. A total station along with GPS measurements was used for the topographic field measurements. The selected areas of the Acropolis of Erimokastro were a characteristic façade of the walls (north oriented façade) ‘figure 1’ and part of the wall at the entrance of the Acropolis (east oriented façade) ‘figure 3’. For the Acropolis of Sarantapixo, part of the remaining north wall was depicted (west oriented wall) ‘figure 2’. These parts of the walls were chosen because they are characteristic architectural elements of both sites are representative of the building materials used and the decay patterns developed are accessible, and their orientation variance or similarity could be used for a reliable comparative study.

Fig3:Characteristic part of the Wall in Erimokastro Acropolis

Furthermore, on the wall facades, non-destructive testing and evaluation techniques were applied in situ, whereas analytical techniques were used in lab after sampling, resulting in building materials characterization and decay diagnosis for both investigated sites. In addition, materials and conservation interventions were suggested according to the results of the integrated diagnostic study.

3. RESULTS AND DISCUSSION

As the data acquisition resulted, the analysis of the facades proceeded and all the diverse data were imported to a GIS platform for both investigated monuments. In order the GIS relational operations to be provided, topology of the data is a prerequisite. Topology of the diverse data is initially built with the creation of layers in the CAD environment. In addition, data retrieval and queries is accomplished with the GIS management and analysis tools.

The attribute dataset consisting of building materials and decay patterns of the wall, resulting from the physicochemical analysis, was imported and aggregated to the attribute dataset created in the CAD environment, containing topological (i.e. perimeter, area, etc.) and descriptive characteristics from the technical report of the strength of the materials, recorded and attributed to the spatial entities, thus, interrelated with the vector data. In the case of Erimokastro Acropolis, the thematic maps of building material and decay pattern are presented 'figure4', 'figure 5'.

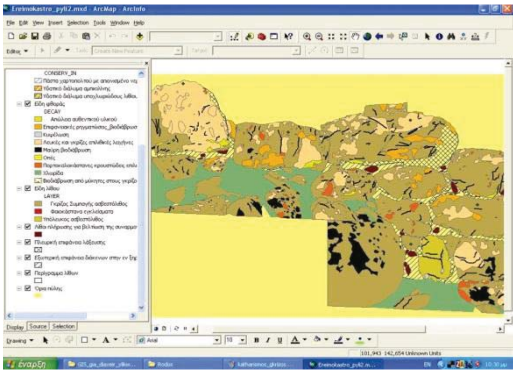

Fig4: Building materials and decay thematic map for the entrance

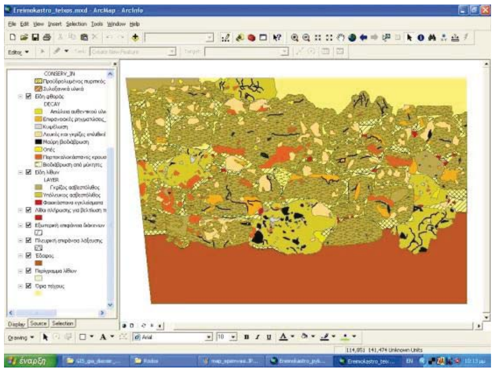

Fig5: Building materials and decay thematic map for the wall

In the case of Sarantapixo, the thematic map of the building material and decay patterns of the depicted wall, where corresponding layers classification and mapping was performed, including all the different kind of materials and decay patterns which were identified by the diagnostic study, is presented 'figure 6'.

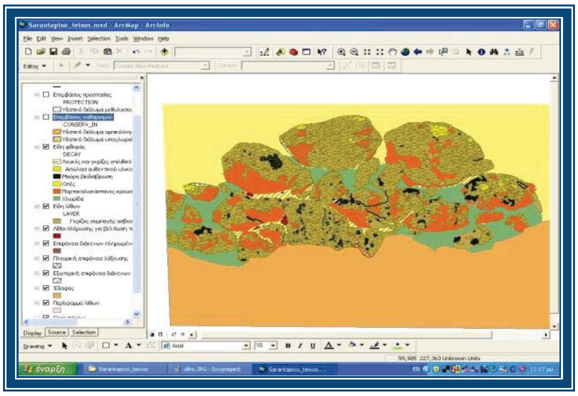

Fig 6: Building materials and decay thematic map for the wall of the Sarantapixo Acropolis

The materials and their decay were characterized using an array of non-destructive techniques validated and supported by a series of analytical methods after sampling. Previous to any conservation intervention applied on the selected facades, a diagnostic study was required to provide the data for the selection of compatible materials and techniques.

The conservation interventions / restorations thematic maps resulted from the geoprocessing analysis in the GIS platform from the materials and decay patterns thematic maps. The features consist of additional attribute data from both input and overlay themes (material / decay). Using the geoprocessing tool of GIS platform, the resulting features include combined spatial properties and attribute data of the decay patterns, additionally classified according to new attribute data sets regarding the suggested materials and conservation interventions. Consequently, each material and conservation intervention is represented by a different layer and is displayed by a different color in the conservation interventions thematic maps 'figure 7, figure8','figure 9'.

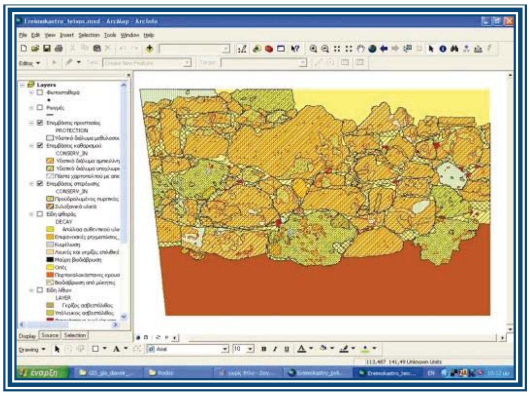

Fig 7:Conservation interventions thematic map for the wall of the Erimokastro Acropolis

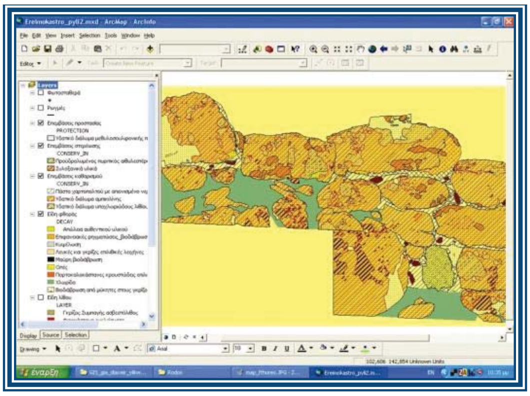

Fig 8:Conservation interventions thematic map for the entrance of the Erimokastro Acropolis

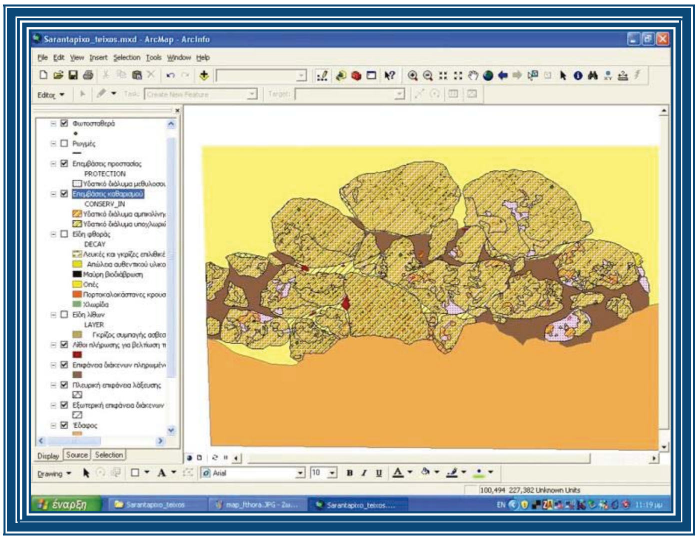

Fig 9:Conservation interventions thematic map for the wall of the Sarantapixo Acropolis

4. CONCLUSION

Protection of cultural heritage requires the preservation of the monuments that are most of the times deteriorating abandoned and left to decay for years and for decades. Thus, preservation of cultural heritage requires a versatile multidisciplinary planning that should be focused on the pathology of the monument and its documentation and on the other hand on compatibility in conservation intervention in terms of sustainability. In the case of Erimokastro Acropolis the diagnostic study results (building materials and decay data) were recorded and attributed to the selected facades which could be applied throughout the entire archaeological site. The same procedure was followed in the case of Sarantapixo Acropolis. GIS modeling provides information about the monument's building materials in the façade of the walls and the extent of decay patterns, as well as the degradation of the building materials regarding their location (proximity of the sea, orientation of the façade, rising dampness etc.). Furthermore, with the GIS analysis tools, on the developed material/decay and conservation interventions/ restorations thematic maps, the monitor of the preservation state of the monument under study, can be achieved and the management of the monument's materials life circle as well as the proposed restoration materials can be evaluated leading to its sustainable protection. Finally, through the management of all these diverse data, data obtained from NDT & E techniques regarding damage assessment on cultural heritage and conservation strategies combined with spatial data, integrated into spatial oriented tools (AutoCAD and GIS), an opportunity is provided to the local authorities and stakeholders to evaluate, assess and plan preservation strategies for the sustainable protection of the monuments.

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