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Big Data Analytics for a Smart Green Infrastructure Strategy

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Abstract: As well known, Big Data is a term for data sets so large or complex that traditional data processing applications aren’t sufficient to process them. The term “Big Data” is referred to using predictive analytics. It is often related to user behavior analytics, or other advanced data analytics methods which from data extract value, and rarely to a particular size of data set. This is especially true for the huge amount of Earth Observation data that satellites constantly orbiting the earth daily transmit.

Keywords: Big Data, Earth Observation data, Satellite imagery.

1. INTRODUCTION

Recently we had a strong increase in all three main dimensions of big data: volume, velocity, and variety. This increase is paralleled by huge amount of new developments related to big data in many fields and enabled by technological breakthroughs and new challenges in hardware and software developments, multi-temporal data analysis, data management and information extraction technologies [1], [2]. Recently we have a new momentum to the field for Big Data from Space thanks to the recent multiplication of open access initiatives that, widening substantially the spectrum of users as well as awareness among the public, are offering new opportunities for scientists and value-added companies.

This is especially true for Space Science and Earth Observation data with the public release of the complete archive of Landsat data by the United States Geological Survey and of the European Copernicus program, whose Sentinel missions operated by the European Space Agency will deliver free and open access to global data in the microwave and optical/infrared ranges. The first one, Sentinel-1A, launched on April 3, 2014, and the second, Sentinel-1B, launched on April 25, 2016, are delivering high-resolution Synthetic Aperture Radar (SAR) global data every 12 days at a daily rate of 2.5 TB. The Sentinel-2A acquires optical data with high revisit frequency, coverage, timeliness and reliability with MSI Spectral Bands span from the Visible and the Near Infra-Red to the Short Wave Infra-Red: 4 bands at 10m, 6 bands at 20m, 3 bands at 60m. It operates in a reference sun-synchronous orbit with a repeat cycle of 10 days for the overall duration of the mission. Sentinel-2B on 2017 will be in the same orbit, allowing a ground-track revisit frequency of 5 days for the dual-spacecraft constellation.
This enormous amount of data is available to extract date information and valuable to the lives of citizens.

2. **GREEN INFRASTRUCTURE**

Green Infrastructure (GI) can be defined as a strategically planned network of high quality. There natural and semi-natural areas with other environmental features are designed and managed for protecting biodiversity in both rural and urban settings, and to deliver a wide range of ecosystem services.

More specifically GI, being a spatial structure providing benefits from nature to people, aims to enhance nature’s ability to deliver multiple valuable ecosystem goods and services, such as clean air or water.

This will in turn:

- Foster a better quality of life and human well-being, for instance by providing a high quality environment in which to live and work.
- Improve biodiversity, for instance by reconnecting isolated nature areas and increasing the mobility of wildlife across the wider landscape.
- Protect us against climate change and other environmental disasters, for instance by alleviating floods, storing carbon or preventing soil erosion.
- Encourage a smarter, more integrated approach to development, which ensures that Europe’s limited space is utilized in as efficient and coherent way as possible.

3. **CASE STUDY**

Big Data Analytics decision support tools with the Smart Green Infrastructure Strategy of Locride can protect the Locride area from environmental disasters and fight climatic change.

One of the key attractions of Green Infrastructure is its ability to perform several functions in the same spatial area. In contrast to most ‘grey’ infrastructures, which usually have only one single objective, GI is multifunctional which means it can promote win-win solutions or ‘small loss-big gain’ combinations that deliver benefits to a wide range of stakeholders as well as to the public at large.

However, for this to happen, the ecosystem must be in a healthy condition.

Strategic level spatial planning will help to:

- locate the best places for habitat enhancement projects (e.g. involving restoration or re-creation of habitats) to help reconnect healthy ecosystems, improve landscape permeability or improve connectivity between protected areas;
- guide infrastructure developments away from particularly sensitive nature areas and instead towards more robust areas where they might additionally contribute to restoring or recreating GI features as part of the development proposal; and
• identify multi-functional zones where compatible land uses that support healthy ecosystems are favored over other more destructive single-focus developments.

Using a strategic approach to building Green Infrastructure ensures there is a clear focus for individual initiatives and local-scale projects so that these can be scaled up to the point where, collectively, they will make a real difference. In this way, Green Infrastructure becomes much more than the mere sum of its parts.

4. **OBJECTIVE**

The proposal aims to create Big Data analytics as a Services decision support tool smart Green Infrastructure Strategy of Locride.

Design Green Infrastructure Strategy area of the Locride based on recovering degraded ecosystem and the improvement of ecosystem services, develops approach to the mitigation of climate change based on the territory. This area encompasses protected areas and Sites of Community Importance (SIC) of Locride as the “Vallata del Novito”, “Monte Mutolo”, “Fiumara Buonamico”, “Fiumara La Verde” and many other protected areas.

5. **METHODOLOGY**

Big Data, as known, refers to the ever-growing amount of more varied, more complex, and less structured information we are creating, storing, and analyzing. The rapid ICT developments such as the Machine Learning, the digitization of collections and social media lead to enormous amounts of data. When hidden patterns in the data become visible, its (economic) value increases. To discover those patterns, breakthroughs are needed in the fields of automatic learning machines, data mining, and visualization, programming languages, software engineering and data protection [3], [4].
In a knowledge economy sense, Big-data-as-a-service (BDaaS) refers specifically to applying insights gleaned from this analysis to drive economic growth. BDaaS is delivered as an analytical tool or as processed information provided by an outside supplier to provide insight into (and plans for creating) a competitive advantage. Such insights are provided by analyzing large amounts of data processed from a variety of sources.

BDaaS aims to form a decision support tools for the Smart Green Infrastructure Strategy. Big Data are a valuable resource and as such, we want to leverage to create value to the organizations as well as to the territory. The value comes from analytics. New source coming from machines, sensors, vehicles, facilities, surveillance, devices, Internet of Things, social media, can be integrated leading to new inside through analytics.

It is a new tool: after software-as-a-service, platform-as-a-service, and data-as-a-service, the next big trend will be BDaaS. In the last few years, many vendors (e.g. Amazon's AWS with Elastic MapReduce, EMC Greenplum, Microsoft's Hadoop on Azure, Google's Google cloud big table, etc.) have started focusing on offering cloud-based big data services to help companies and organizations solve their Information management challenges.

Some analysts estimate that the portion of business IT spending that is cloud-based, -as-a-service activity will increase from about 15 percent today to 35 percent by 2021.

The diagram above depicts various layers that are required to provide Big Data as a service. The bottom most layer represents infrastructure-as-a-service components such as compute-as-a-service (CaaS) and storage-as-a-service (StaaS) and their management. On the next layer up, service providers offer database-as-a-service (DBaaS) or data aggregation and exposure as part of data-as-a-service (DaaS). The next layer up in this BDaaS architecture is data platform-as-a-service. As user expectations for real time grow, real-time analytics need to be enabled, and this occurs in the topmost layer; users of analytics-software-as-a-service can generate their own reports, visualizations, and dashboards.
6. **Approach Smart Green Infrastructure Strategy of Locride**

Fig. 5 - Strategic Plan of Locride 2015, Framework (courtesy of “Locride Ambiente”).

A strategy aimed to recovering degraded ecosystem and improving ecosystem services, develops an approach to the mitigation of climate change on the territory; it is a connection structure protected areas and coastal areas: marine park Costa dei Gelsomini, area SIC Fiumare National Park of Aspromonte.

A strategic plan for development action, multiple use farm land, grazing areas bushy Fiumare, civic uses and rationalization of public use, establishes the guiding criteria for recovering degraded zone coastal and foothills areas of the Locride, and:

- Restore embankment, and flood prevention of the Fiumare;
- Restore damp and conservation Habitat of the birds;
- Restoration degraded ecosystem of evergreen forest Mediterranean and improvement of the landscape.

It improves ecosystem service: prevention risk, ecotourism development, cultural landscaping, recreation, education of the Locride schools.

6.1 **Demand for Smart Development Strategic Objective for Locride Area**

There is more in a rural area pressure to deliver cost-effective and reliable sources. At the same time, consumers are demanding more control over their own consumption. There's a strong requirement for smart development of rural area of insights analysis in order to make more effective decisions on:

Short and long-term strategical objectives are the answers to these questions:

- How can we better manage the huge influx of data?
- Can we more effectively use past history to predict outages and track demand patterns?
- About our service, how can we better understand public sentiment and identify areas that can help address customer concerns?
• What can we do to empower consumers to lower their consumption?
• How do we manage forecasting models and capital planning to maintain profitability while meeting stringent standards also towards the partnership agreements?
With advanced analytics [5] – [8], it can integrate and analyze structured data together with unstructured data to gain insight into performance, customer service and other key aspects of the smart development:
• Transform the platform from a rigid analog system to a dynamic and automated delivery system.
• Empower consumers by providing them with near real-time, detailed information about their usage.
• Meet stringent greenhouse gas emissions targets while maintaining sufficient cost-effective power supply.

6.2 Present Situation
Most of projects in the rural area are not properly economically utilized, due to a lack of understanding the function as smart community strategy service for a new economic development model. The lack of understanding of a strategy for an intelligent integration of the tree layer of observation data, telecommunication and analytical tool as key driver for sustainable economic development of the rural area.

6.3 Smart Solution
With data (Big Data, as satellite imagery - Sentinels), machine learning and advanced analytics, it can integrate and analyze structured data together with unstructured data to gain insight into performance, citizen service and other key aspects of development. Big Data technology is the cornerstone to know and monitoring the long-term strategical goal of the Locride area.

6.4 Embedding Management Analytics
Most Management Systems should also take advantage of the information available to improve the accuracy and effectiveness of decision. Unlike human decision-makers, cannot use analytical tools and reporting technologies to understand the situation. In the Management Systems of a smart rural area must therefore embed predictive analytic visualization models derived from historical data using advanced analytical tools. Such models assess the likelihood that something will be true in the future and make this assessment available to the decision logic in a Management System, allowing decisions to be made in this context [9], [10].

By presenting these data to humans, so that they can acquire insight from it, it is possible embedding analytic visualization insight in systems with predictive analytic techniques.

6.5 Optimization of management and implementation
Management as visualization System rely on resources that are not unlimited [11]. Whether these resources are staff, service, capacity, territory resource allocation, management must often be made in the context of a constrained set of resources. The management structure will generally want to optimize their results given these constraints and this means that trade-offs must be made. The aim of management service will adopt optimization and simulation technologies to manage trade-offs and to ensure that the management decisions are made in a way that produces the best possible results given the constraints on decision-making. These
technologies allow modelling of the constraints and trade-offs and then use mathematical techniques to pick the set of outcomes that will maximize the benefit to the management structure. These models can also be used to drive simulations of various SCSS scenarios to see which will produce the best outcome for the management service.

6.6 Monitoring

The nature of management service decision-making is that it is often not possible to tell how good a management decision will turn out to be for some time [12]. As a result, the ongoing monitoring of decisions made and their outcomes is important. Such monitoring allows management decision-making to be systematically improved over time both by tracking management decision performance and making changes when this performance is inadequate and by conducting experiments and analyzing the results of these experiments. Most organizations will use their data infrastructure and their Performance Management to conduct much of this analysis [13].

![Fig. 6 - Helix-Nebula Platform architecture.](image)

Infrastructure Helix Nebula Platform Big data Analytics as a Service supports services Smart Green Infrastructure Strategy of Locride.

![Fig. 7 – Evaluations and final report.](image)
7. CONCLUSION

The term big-data-as-a-service may not be elegant or attractive, but the concept is solid [14]. As more organizations realize the benefits of implementing big data strategies, more vendors will emerge to provide such supporting services to them. With the growth in popularity of software-as-a-service, organizations are getting used to working in a virtualized environment via a Web interface and integrating analytics into this process is a natural next step.

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