

# GMES and INSPIRE: Harmonising Cross-Thematic Environmental Data For Integrated Intelligence

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## ABSTRACT

GMES and INSPIRE are mutually beneficial and require close collaboration between communities from both domains to mitigate and adapt to environmental and security challenges. For example, extension of GMES services into the cross-cutting domains of Security, Emergency Response and Climate Change re-enforce the need for cross-thematic data harmonisation and interoperability between services which can be fulfilled by INSPIRE based initiatives. In this regard, the FP6 HUMBOLDT project provides various INSPIRE and OGC compliant tools, components and services that are applied on various environmental scenarios related to GMES application domains. In this paper, we discuss the HUMBOLDT urban scenario where the aforementioned cross-thematic harmonisation and interoperability practices are critically necessary to advance integrated urban management, with the objective to identify potential contributions towards GMES initial operations.

**KEYWORDS:** Environmental ecosystems, integrated information intelligence, INSPIRE, GMES, HUMBOLDT, cross-thematic harmonisation

## 1. INTRODUCTION

In Europe today, the recent development of new methodologies for information acquisition including the Global Monitoring for Environment and Security (GMES) [1] as a top-down approach, allied with new information provided by member states in response to various EU Directives including Air Quality, Water, Noise, etc mostly compliant to the INSPIRE Directive, [2] has contributed towards more effective environmental monitoring, in order to adapt to, and mitigate environmental challenges such as climate change, biodiversity loss, human well-being, security, etc. However, this information remains typically fragmented and requires a more integrated perspective in order to secure the intelligence necessary to effectively manage the various environmental ecosystem facets including urban, biodiversity, atmosphere, marine, risk and security, climate change, etc.

More specifically, from a user perspective, the main objectives include:

- unravelling the expected and unknown environmental problems by investigating the relationship between various environmental variables;
- enabling access to cross-thematic environmental monitoring information for climate change mitigation and/or adaption, security risks, etc;
- facilitate various stakeholders in generating outputs for various environmental indicators mainly for decision-making and policy development activities.

The solution to the above requirements necessitates utilisation of data from various sources, application of harmonisation mappings and transformations according to European standards such as INSPIRE, performing analytical processing and the generation of required outputs such as environmental indicators for various policy related requirements such as the EU 2020

strategy [3], SEBI indicators [4], indicators for environmental changes and causality, prediction of future environmental changes based on the existing temporal data, identification of potential security risks, environmental risks such as floods, etc.

Such integrated intelligence for environmental ecosystems management requires utilisation of both space-based and in-situ data distributed across Europe to analyze, monitor, and assess according to various stakeholder requirements.

In general, the integration of environmental data may be performed in relation to two relevant axes: vertical integration across different scales of governance e.g. local to national, EU and global levels, and horizontal integration between sectoral competences at the local level. Both integration axes require complementary services, in-situ and space based data and sharing of experiences from INSPIRE and GMES domains.

In the above context we briefly discuss GMES and INSPIRE mutual benefits in section 2 followed by a case study on Urban Ecosystems in Section 3. In Section 4, we briefly share experience from the HUMBOLDT project and finally we conclude in section 4.

## **2. GMES AND INSPIRE**

GMES and INSPIRE are mutually beneficial to the extent that:

- INSPIRE benefits from the GMES service use cases and reference material for service specifications that contribute to INSPIRE data and service specifications work;
- Closed collaboration between GMES and INSPIRE communities in order to share experiences and provide complementary services;
- GMES service domains (land, marine, atmosphere), require coordination for the intersection between the domains and for the use of commonly agreed geospatial reference data sets;
- GMES can provide Very High Resolution data and/or maps with rapid update frequency that is useful for local policy related decision-making processes and other initiatives following bottom-up approaches such as INSPIRE; and
- Extension of GMES services into the “horizontal” cross-cutting domains of Security, Emergency Response and Climate Change re-enforce the need for interoperability between services;

GIO (GMES Initial Operations) [5] land services will be operational and as such an integrated part in support of operational workflows in the public interest domain. Land services should be therefore fully compliant with INSPIRE specifications and guidelines.

## **3. CASE STUDY: LAND – URBAN ECOSYSTEM**

More than 80% of the population of Europe live in the cities and towns of Europe, and yet the rate of urbanisation both in Europe and globally continues to rise [6, 7]. Urban living is the preferred option for societies throughout the world, delivering a major dynamic for economic development.

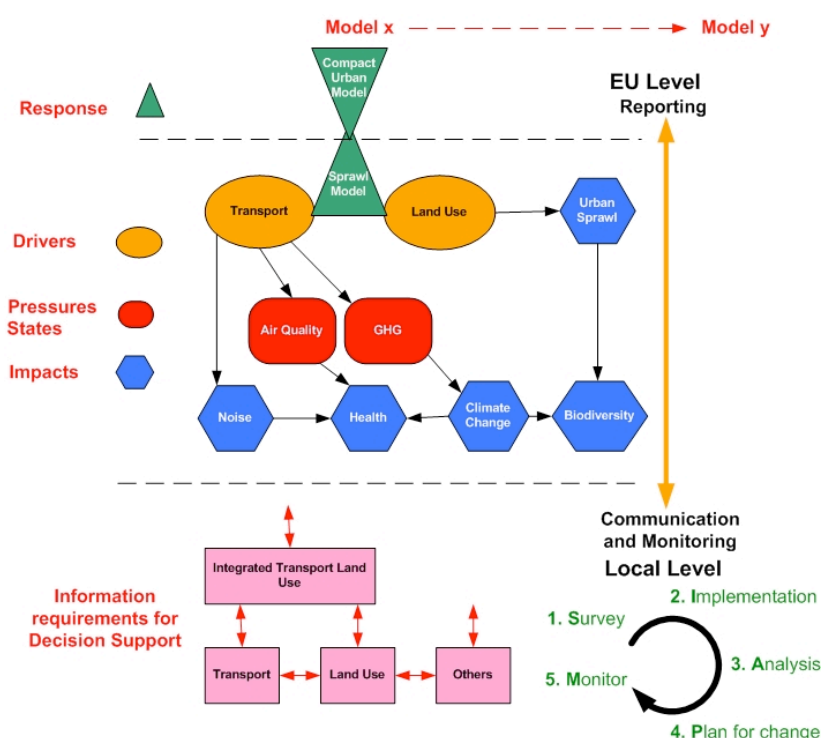
However, at the same time this urbanisation process is exacerbating the range and complexity of social, economic, security, risk and other environmental challenges impacting on cities. Urbanisation processes not only in Europe but also globally, are a major force for socio-economic evolution generating significant environmental impacts. The complex and inter-related drivers of change at the urban level that fuel the urbanisation process can create

poor human health outcomes, vulnerability to environmental risk, biodiversity loss, excess GHG emissions, which in turn exacerbates climate change. Nowhere is this more evident than in the phenomenon of urban sprawl, characteristic of much of European urban development today, which is generating major largely uncontrolled greenhouse gas emissions (climate change) as a result of the accelerating growth of urban transportation.

Major “win-win” policy co-benefits exist in reducing greenhouse gas emissions whilst enhancing human health, secure and less prone to environmental risks, achieved by the promotion of more compact and less sprawling cities throughout Europe. However, the interconnectedness of urban drivers precludes the attainment of these policy co-benefits, unless measures of integrated environmental monitoring and management are deployed. One of the major requirements for the realisation of an integrated environmental monitoring system are tools and services to harmonise and integrate environmental spatial data, originating from various governmental and other agencies, e.g in-situ and space-based data, connected horizontally at the local, National and EU levels, using standards like INSPIRE, OGC [8], etc.

In response to the above serious environmental concerns for urban Europe, the need to secure cross-thematic data harmonisation and interoperability between the information and management systems of local urban planning agencies is nowhere more evident than in the urban context.

Figure 1 depicts urban change drivers and impacts in relation to integrated urban monitoring that can support the key political concerns of European cities to effectively respond to climate change, greenhouse gas emissions, uncontrolled urban sprawl, urban health and biodiversity loss etc, all of which are fundamentally related in the land-use-transport-environment nexus.

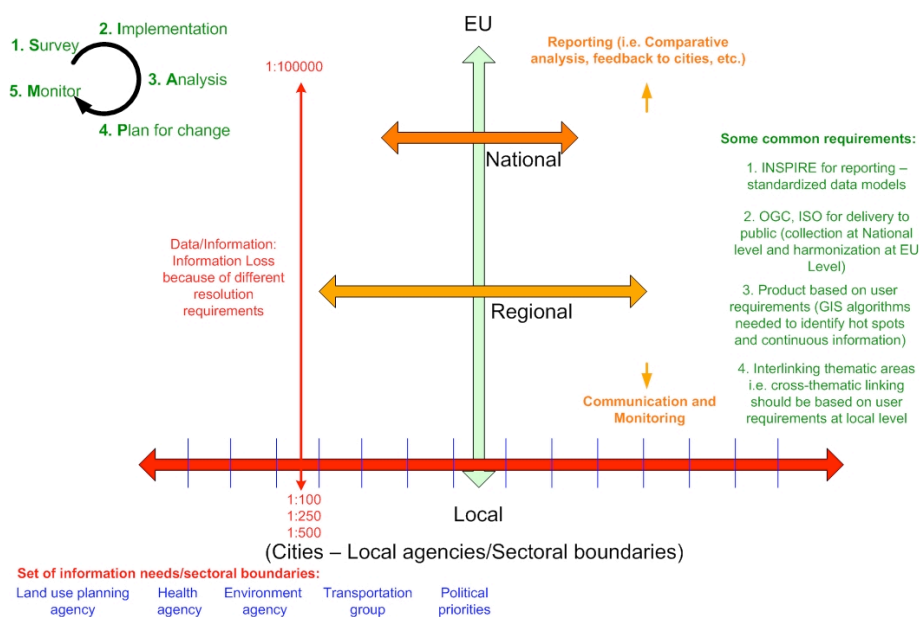


**Figure 1: Urban Change Drivers and Impacts**

Effective responses to these prime urban management challenges are inhibited by the complexity and interconnectedness of these urban drivers of change. Yet at the same time this very interconnectedness of drivers points to the tremendous opportunity that exists in the creation of effective urban management solutions based on the complementary services provided by GMES and INSPIRE initiatives. Because of this connectivity, alternative models of urbanisation that support more compact and less sprawling cities permit the achievement

of the “win-win” policy co-benefits that reduce greenhouse gas emissions simultaneously enhancing human health and security, reducing environmental risks, and minimising biodiversity loss.

For a number of years there has been a wide consensus that integrated urban management solutions offer the most effective means of addressing the management of the complexity of urban development. European projects including Managing Urban Europe 25 [9] have defined the fundamental principles upon which these integrated urban management systems can be developed. Similarly, European Environmental Agency’s initiative towards an Integrated Urban Environment for Europe (IUME) [10] is another initiative attempting to mitigate the same urban challenges. But turning the principles into an operational reality offering specific decision-making support to the urban planners has remained elusive. Fundamentally, a coherent information intelligence response requires connected information between various departments at the local and regional levels (including earth observation data) and flows of information between various levels of governance from local to EU and vice versa as depicted in Figure 2.



**Figure 2: Vertical and Horizontal Information Integration**

#### 4. THE HUMBOLDT PROJECT

Today the opportunities to create the operational decision support systems that are required to meet the challenges identified above are substantially enhanced by advances in ICT applications that address the integration requirements for urban planning. The FP6 HUMBOLDT project [11] has demonstrated the huge potential for technology applications to support the realisation of integrated environmental monitoring systems based on the development of tools and services that harmonise and integrate cross-thematic environmental spatial data, originating from various governmental and other agencies (e.g. in situ and space-based data) connected horizontally at the local, national and EU levels, using standards like INSPIRE, OGC etc.

The HUMBOLDT project provides various INSPIRE and OGC compliant state-of-the-art harmonisation tools and services (e.g. GeoModel Editor, Humboldt Alignment Editor (HALE), Conceptual Schema Transformation (CST), Edge Matching Service (EMS), Workflow Design and Construction Service (WDCS), etc) establishing a platform for developing cross-thematic harmonized environmental applications. These HUMBOLDT tools and services are applied in various environmental scenarios (use cases) in the domains of urban planning, forest, ocean,

protected areas, river catchments, air quality, risk management and border security, where they are developed in respect of real-life use cases with the objective to demonstrate the effectiveness of the HUMBOLDT framework, compliance to INSPIRE standards and contributions towards GMES.

Specifically the HUMBOLDT Urban Atlas scenario is an effective attempt to mitigate the cross-thematic harmonisation challenges providing the key to unlock the prime concerns of the policy end user to ensure integrated intelligence that is critical to effective decision-making and policy integration. The HUMBOLDT Urban Atlas scenario demonstrates how non-standardised spatial environmental data from the sustainable observatory of the city of Vitoria-Gasteiz (CEA) [12] becomes compliant with European standards using the Humboldt framework, providing interoperable communication with other European spatial data infrastructures (ESDIs) and generating new environmental indicators at the local level [13]. Though the HUMBOLDT Urban Atlas scenario did not attempt to cover the myriad challenges discussed above, it nonetheless provides a suitable first step towards achieving the integrated intelligence using cross-thematic environmental data originated either from local sources or space-based components.

## 5. SUMMARY AND CONCLUSION

In looking forward to consider the future perspectives for the evolution of urban environmental management systems, the further development of technology applications such as those identified above, as well as the effective engagement of the dynamic generated by the political initiatives supporting these technological applications becomes increasingly critical. INSPIRE together with GMES offer tremendous opportunities for the further development of urban environmental management systems, provided these resources are effectively harnessed.

Two preconditions exist in relation to this qualification concerning the future evolution of urban environment management systems. First, that the user-defined principles for urban environmental management systems are fully understood and responded to in the design and implementation of the technological evolutions envisaged. Second, that the interrelationships between the various political initiatives including INSPIRE and GMES and also GEOSS [14] and Shared Environmental Information System (SEIS) [15] are fully understood, so that the full benefits of a coherent and co-ordinated political drive, rather than discordant and conflicting actions are available to support the development of environmental management systems with possible sharing of experience and support from the existing projects such as the HUMBOLDT project, etc.

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