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Spatial Informatics for Emission Reduction

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1. Introduction

The challenges of the late 20th and early 21st century: the revolution of modern technologies, the globalisation process, the fiscal sustainability crisis, energy crisis, climate change and environmental sustainability render it inevitable that answers are sought in new approaches. In the European Union, the Lisbon process brought change in attitude. The experiences obtained in the implementation, first of all, the significant lags behind the plan urge the acceleration of making changes. The most important means for this is the highest level and widest application of infocommunication technologies; the fastest possible build-up of information (knowledge based) society.

This presentation discusses the outstanding role spatial informatics – as one of the new tools provided by information technology – plays, and should play, in the Kyoto process, through its application in two significant areas of economy – transportation and forest management.

2.Spatial informatics in transport development for emission reduction

2.1The concept of intelligent infrastructure

The concept of infrastructure changes and expands as an effect of the change led by infocommunication. The traditional physical infrastructure systems and the services based on them are increasingly less separable; they tend to constitute complex entities, infrastructures of a broader sense. This inherent cooperation, mutual interaction opens up new vistas: integrated solutions, more effective operation, higher level, more comfortable, and last but not least, more energy saving and environmentally friendly services are now offered.

This change is addressed by the new European Union infrastructure policy, which does not emphasise quantity driven development, but establishes the cooperation between the existing physical and intellectual infrastructure elements and the services realized on the basis of and by these elements, and – by creating new quality systems and services – renders the development and operation of these more innovative and effective. By the insertion of infocommunication technologies and the establishment of interoperability the constituents of the system should be capable of providing information about their own status, process and interpret this information, exchange information among

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themselves and intervene. The totality of new complex systems created in this manner is intelligent infrastructure.

Spatial informatics, which is a novel area using cutting-edge infocommunication tools for the input, storing, analysis and presentation of spatial information, plays a natural role in the establishment and operation of intelligent infrastructure.

2.2 The Development of Infrastructure

By applying infocommunication technology, the effectiveness of transportation systems can be increased for both the service provider and the user. Now, this technology is not only a supporter and assistant to the traditional transportation modalities, but has become an independent medium for interpersonal and interinstitutional relationships. The spread of 'virtual mobility' is of key importance not only in the aspect of costs, but also in environmental load considerations. Nevertheless, we must note that even though 'virtual mobility' will certainly replace certain forms of physical transportation in a number of areas, physical transportation will keep growing even in the long run.

Transportation industry holds a significant position in EU economy: it gives 7% of gross national product, again 7% of employment, 40% of Member State investments, and 30% of the energy consumption of the Community. The growth has been more or less uninterrupted in the last 20 years; 2,3% in freight transport, and 3,1% in passenger transport. Several studies estimate that road freight transportation will increase by more than 50% in the new Member States by 2020.

The more tight-paced, information-intensive economy and new production and management methods radically transform the transport requirements of companies and individuals. Besides quantitative growth, transport systems also have to meet reliability, cost-efficiency, timeliness, safety and environment requirements. All these requirements also tend to encourage a more intense application of infocommunication technologies, as these challenges can only be satisfactorily answered by complex, intelligent transport infrastructure.

2.3 Spatial Informatics for Intelligent Transport

Intelligent transport infrastructure is the totality of integrated transport systems applying the tools of informatics and telecommunications. For the various tasks of road, rail, waterway and air transport, individual intelligent transport systems can be created. The major elements of the operation of intelligent transport systems are:

- Navigation-spatial informatics element;
- Telecommunication element;
- Other spatial informatics element;
- Control centre.

The most frequent spatial informatics functions of intelligent transport systems operation are as follows:

- Map Matching: the matching of the position of the vehicle and the route on the digital map;
- Best-route calculation: the determination of the shortest distance, fastest, etc. route;
- Route Guidance: assisting the driver in following the selected route (may include audio prompts besides the visual effects);

- Traffic Signal Control Systems: interconnected electronic systems that control a network of traffic signals to reduce travel time, increase fuel efficiency, reduce emissions, and increase safety for vehicle movements at intersections;
- Traffic Load Control (Open Route Management): systems that monitor traffic and offer congestion free routes to drivers to reach their destination.

These functions result in significant time, energy and cost savings. At the same time, these reduce the environmental load effect of transport, and unambiguously improve traffic safety. An additional element on the area of freight transport manifests itself in the form of better organization of freights, the continuous tracing of goods, even the assistance in customs procedures.

2.4 Environmental protection potential in the development of intelligent transport

The development of intelligent infrastructure has significant environmental improvement potential, as the share of the transport industry in total emission is rather high. In Hungary, nearly 60% of carbon monoxide, 20% of carbon dioxide and more than 55% of nitrogen dioxide emission is produced by the transport industry. The potency of the environmental load effect also depends on the height where the gasses are emitted to the air. In this aspect, road transport has the most negative effect. CO2 emission in the various methods of transport in 2005: road: 12,002,500 ton/year, rail: 190,300 ton/year, waterways: 150,000 ton/year, air: 105,000 ton/year (only landing, taxiing and takeoff).

Objectives of intelligent transport – as already mentioned – primarily concentrated on the smoother flow of traffic, capacity growth, congestion avoidance and transport safety improvement. It was not until lately that the decrease of consumption and the decrease the environmental load of transport surfaced as priorities.

It is an encouraging sign that among the main objectives of the 2001 Transport White paper the European Commission includes ‘external costs’ of transport, such as environmental load, and partially related, the development of intelligent transport infrastructure systems. The Commission by adopting an action plan in December 2008 intended to accelerate the introduction of intelligent transport systems, as these solutions can contribute to the establishment of an environmentally friendly transport.

In coherence to the above, from the results of the earlier introduction of intelligent transport systems, we can only indirectly infer to the decrease of environmental load (primarily CO2 emission):

The statement of the EU White Paper should be noted first according to which the effect of intelligent transport systems on the environment is rather favourable, for example, emissions may decrease by 5% due to the drop in congestions. Even better results are reported from the urban use of intelligent traffic light control systems:

Decrease of fuel usage (also CO2 emission): 6% - 12%; carbon monoxide (CO) emission decrease: 5% - 13%; hydrocarbon (HC) emission decrease: 4% - 10%.

(Source: Intelligent Transportation Systems Benefits, USDOT)

In Hungary, a spatial informatics based traffic light control systems are operated, as well. In the city of Pécs, the system ensures free traffic for public transport. Buses are equipped with satellite positioning, GP and onboard computer. These instruments are capable of contacting traffic lights to request green light. Traveller information boards display the expected arrival of the buses.

3. Spatial Informatics and Forest Management in Climate Protection

3.1 Spatial Informatics in Forest Management

The European Union coded in community regulations the unambiguous identification of agricultural land and parcels, the establishment and operation requirements of an identification system enabling the digital, spatial informatics management of their data. The common European Union spatial informatics system is a quality jump in the spatial information provision of the countries with its relatively fast tracing of land usage changes and its widespread use including farm managers on the areas of agriculture, settlement development and environmental management, as well as in the control of existing national spatial informatics data systems. The basic units of the system are physical blocks, associated units of land surface that are enclosed by physical elements identifiable on site and are static over time (road, rail, embankment, forest belt). The spatial informatics system consists of raster, vector and alphanumeric basic data. Orthophotos are used as the basis and map background for vector data generation, while in some cases high-resolution satellite images are used. The system contains thematic coverages supplementing its basic data.

Countries roll out the system individually. In Hungary, it is the Hungarian Land Parcel Identification System (LPIS-Hu; MePAR in Hungarian). In the course of updating the LPIS-Hu with the new half-meter resolution colour orthophoto background, if necessary, by involving satellite images assisting the identification of surface vegetation changes are registered itemised. The itemized examination of LPIS-Hu physical blocks is aided by their own developed process-controlled spatial informatics software integrating aerial and satellite images, and vector data. The system ensures the traceability of any change.

Environmental surface changes that took place in previous times (10-30 years ago) can usually not be revealed or only imprecisely and with excessive expenditure with ‘traditional’ methods. With the aid of available satellite imagery, data can be obtained quickly and objectively even for 30 years ago (e.g.: precise registration of forest cuttings of the past, changes in water surfaces, change of the extent of green vegetation, etc.).

This may be especially important when we intend to examine a complex system of relationships, or the newly surfacing problems (climate change, CO2 emission) caused by the quick change of our environment that are rooted in the past, and we do not have other data from the that time.

Land cover can be recognized by colour for each pixel; land usage by the defined structure of land cover elements, and by the use of supplemental information (e.g.: topographic map). A typical example: ‘forest’, as regards land cover, is an area presently covered with trees, while from the point of view of land use, areas freshly deforested and waiting for forestation are also considered as ‘forest’.

EU Member States commenced the CORINE (Coordination of Information on the Environment) Land Cover (CLC) project of the European Union in the 1980’s with the objective that they obtain common and comparable data on land cover at the 1:100,000 scale. The CORINE database consists of 44 categories unified on the European level containing land cover and land usage elements, as well. The first survey was concluded at the end of the 1990’s. The renewal of the CLC database and the management of the land cover change database are performed simultaneously: the mapping of land cover change in Europe between 2000-2006 is still underway, while another survey is being prepared to map the land cover changes between 2006 and 2009.

In the registry of greenhouse gas (GHG) emission, to trace land usage change, several countries use CORINE land cover databases obtained from remote sensing data. Forestry registries that form the basis of forest inventories are also mostly based on remotely sensed data. LPIS-Hu contains a definition of the registry and delimitation of forested areas.

3.2 The Role of Forest Management in Climate Protection

A determining part of greenhouse gas emissions can be linked to industrial production, energy supply and transportation. However, carbon load stemming from the decrease of forested land area is stunningly high; making up for 20% of the surface emission of GHG, more than the total greenhouse gas emission of the European Union. Currently, approximately 30% of the land area is covered by forests, which forests are the most significant carbon dioxide storages of Earth ecosystems besides oceans. These not only store carbon in their timber, but even continuously absorb carbon while growing, thus reducing its atmospheric concentration as a ‘sink’. Unfortunately, the development of human civilisation came with the radical decrease of forested areas, as still seen today. In the period between 1990-2005, we lost 3% of the forests of Earth, and due to the forest clearings of developing countries, forested areas decrease by 13 million hectares annually (an area comparable to that of Greece).

While in some countries, due to economic constraints, deficiencies of regulation, and tradition, the size of forests decrease with an area larger than the area of Hungary, in Hungary, similarly to European tendencies, the extent of logging is significantly below the annual growth of forests, therefore the national forest property, the carbon absorbed in forests increases. The forested area has been constantly growing since the end of World War I; in the last 90 years it grew from 1.1 million hectare to 2 million, by exactly 25% in the last 25 years.

Besides the growth of forested land areas, the increase of trees, termed as 'live tree stock' is decisive, as this accumulates carbon. The live tree stock of Hungarian forests has also been continuously on the rise.

The Kyoto protocols regard the tackling of the decrease of forested land area and the growth of forest coverage as cost-effective methods for the fight against climate change, and promote these. In the Kyoto system there is an option to compensate for the GHG emission of industrialized nations, to utilise carbon dioxide sinks, in the frame of this to implement forest planting. Forest planting is a recognized and effective way to moderate climate change. Hungarian forests, according to the report for the UN climate change framework agreement, decreased atmospheric CO2 quantity by 4.3 million tons in 2007 in the form of permanent carbon absorption.

In the frame of the Kyoto protocols, signatory countries have the option to sell CO2 quantities – CO2 unit or Kyoto unit – not used in their own national frames which may include the amount of CO2 absorbed by sinks, that is, forests. According to Paragraph 3 of Article 3 of the Kyoto Protocol, carbon absorbed in forests planted since 1990 shall be reported in full and compulsorily in the national GHG store. Hungarian preliminary calculations show the carbon dioxide absorption of such forests to be around 1 million tons annually. Signatories can optionally commit themselves to the ‘forestry management’ option as set out in Paragraph 4 of Article 3 of the Protocol. The essence of the commitment is to prepare the carbon inventory and inclusion thereof in the national GHG inventory for the complete forest areas besides the forests falling under the force of Paragraph 3 of Article 3.

As the Hungarian National Forest Programme calculates with the increase of forested areas and the growth of tree stock on the long run (annually a further 3-3.5 million ton CO2 can be absorbed permanently in new forests), Hungary committed herself to the option of Article 3.4 for the Kyoto reports.

It should be noted that the prerequisites to incomes realised in international emission trade include the preparation of a good quality national GHG inventory assembled under the Kyoto Protocol, the continuous monitoring of changes, the possibility of independent audit of commitments. These terms are remarkably similar to those required in the current European agricultural subsidy system. Consequently, the most effective method for European countries committing themselves to the forest management option in quota trade is to ensure these pieces of information by the further development of the already existing spatial informatics system.

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