DIGITAL EARTH APPROACH for PAN-EURASIAN EXPERIMENT (PEEX Program)

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ABSTRACT

Pan-Eurasian Experiment (PEEX) is a multi-disciplinary, multiscale initiative project addressed global challenges, such as climate change and air quality. Therefore, PEEX data should be combined with unique global multiscale geospatial context. This type of context is provided by Digital Earth concept only. Synthesis of PEEX data and Digital Earth geospatial context within same framework provides new quality of situational awareness through synergy of heterogeneous dataset. In the paper theoretical aspects of PEEX and Digital Earth as well as implementation of this approach are discussed.

Key words: PEEX, Digital Earth, Digital Protvino.

PEEX CURRENT STATUS

Pan-Eurasian Experiment (PEEX) program (https://www.atm.helsinki.fi/peex) is a multi disiplinary, multiscale bottom up initiative launched in 2012 by the University Helsinki (Atmospheric Sciences) and Finnish Meteorological Institute together with the strong support by the Moscow State University (MSU) and AEROCOSMOS. These institutes have been the leading initate partners in PEEX. [Lappalainen et al. 2014]. The main focus of PEEX is to solve interlinked global challenges, such as climate change and air quality, influencing societies in the Northern

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Eurasian region [Kulmala et al. 2015]. At the moment the initiative is involving research communities from Russia and China and from several countries in Europe. Altogether 80 institutes have contributed the PEEX Science Plan, which identifies the PEEX Program and introduces the research agenda, the components of the future PEEX research infrastructure and the topics relevant for impact making and outreach activities. The PEEX research agenda identifies the most urgent large scale research questions and topics of the land-atmosphere-aquatic-anthropogenic systems and interactions and feedbacks between the systems for the next decades [Lappalainen et al. 2015]. This expedites the utilization and combining of new scientific knowledge for producing a more reliable climate change scenarios at regional and global scales, and enables mitigation and adaptation planning of the Northern societies.

At the moment PEEX is collecting new scientific knowledge via opening of PEEX Special issue in the Journal of Atmospheric Chemistry and Physics (http://www.atmos-chem-phys-discuss.net/special_issue265.html). The special issue serves as a first platform collecting PEEX relevant scientific results for the first PEEX science assessment. PEEX will also setup a research approach where the environmental observations are analyzed together with the societal data for predicting future pathways of the Northern Pan-Eurasian environments and societies. The Assessment(s) will be distributed to different stakeholders and policy making processes such as Arctic Council, IPCC, Future Earth and the European, Russian and Chinese ministries.

PEEX operates in an integrative way; and it aims at solving the major scientific and society relevant questions at many scales using tools from environmental and social sciences and economics (fig 1.). Compared to traditional cartography methods Digital Earth play crucial role when large quantities of different type of datasets (environmental, social, economic parameters) are analyzed and the research results needs to visualized and introduced in an end-user friendly way. This is especially case when the analysis needs to be introduced to decision makers. Furthermore, the Digital Earth – Google Mapping can used in educating scientist in order to make powerful data analysis.

Nevertheless, implementation of Digital Earth concept for aggregating vast quantities of data in multiscale manner raised questions, because multiscale representation is strictly prohibited by fundamental rules of cartography. Therefore, we need to investigate the nature of Digital Earth itself and evaluate scientific background of new approach .

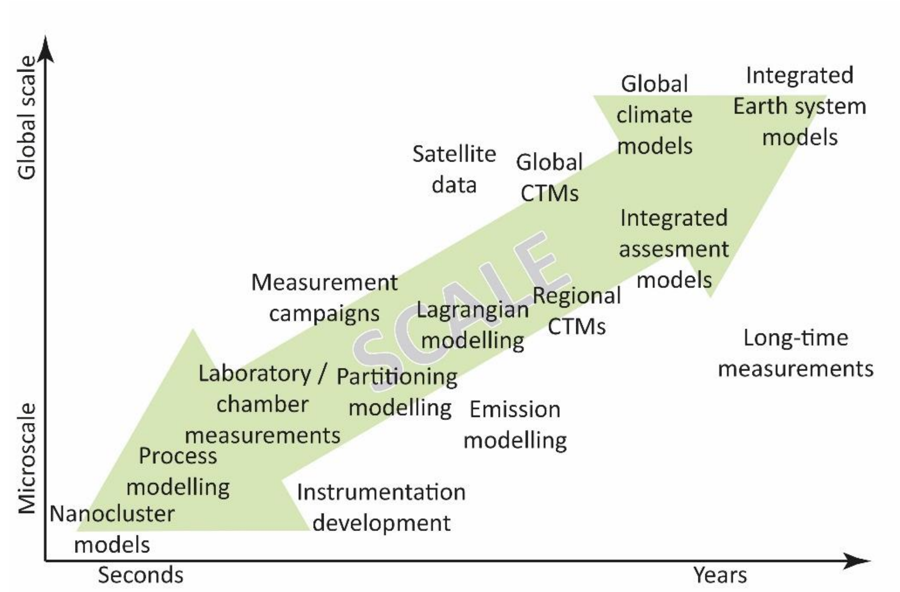

Figure 1. Examples of the temporal and spatial scales of modeling and observations within the PEEX (Kulmala et al. 2009).

DIGITAL EARTH AS A FRAMEWORK FOR PEEX: THEORETICAL ASPECT

Geoservice Google Earth, opened in 2005, was the first obvious example of the implementation of the concept of Digital Earth, foreseen by US vice-president Al Gore a decade earlier [Gore, 1998]. New product turned out to be extremely innovative, therefore its relationship with cartography raised questions. It has been suggested the emergence of a new class of geospatial applications that are qualitatively different from the previous one - maps and GIS. It is widely believed that Google Earth is a summa of new technologies, not a new science.

International Society for Digital Earth (ISDE) defines Digital Earth as a 'global and interdisciplinary initiative to construct a comprehensive virtual representation of the planet' [ISDE 2006]. This definition emphasizes social aspect of the phenomenon, however, hides the question of the presence of scientific novelty.

Obviously, Digital Earth differs essentially from mapping products, like GIS, but relations between cartography and Digital Earth remains controversial and discussable. On the one hand, Digital Earth is deeply rooted in classical cartography and belongs to same domain area. On the other hand, new approach dramatically contradicts basic principles of mapping. For example, Digital Earth is completely avoiding map projections [Goodchild et al., 2012], so it is not a cartographic product. To a certain extent Digital Earth is 'impossible object' for classical cartography, because it combines global coverage with topographic accuracy for whole Globe; it is impossible in classical cartography. It means Digital Earth is a not a map or map-like product in classic terms, and we need a classification model for different geospatial products.

First attempt to provide a new classification of different geospatial products was made by Andrew Turner [Turner, 2006]. He combined the variety of new geospatial products, including Google Earth, into new genus, or realm, called 'neogeography'. This new genus was located 'outside the realm of traditional GIS, Geographic Information Systems' (Fig. 2). Also he defines neogeography as a generic term for very broad range of new products and 'set of techniques and tools'. However, the proposed definition of neogeography is not shed light on the nature of the neogeography itself and does not provide clear and useful criterion of classification.

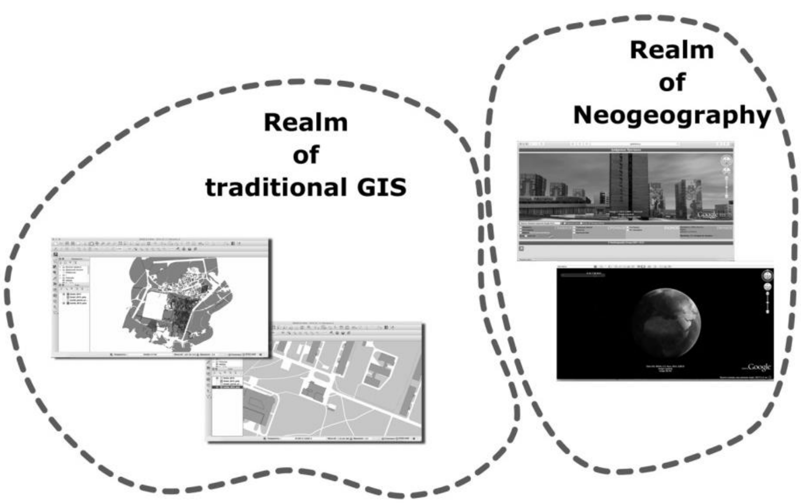

Figure 2. Representation of two geospatial realms by Andrew Turner's definition of neogeography

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Really, neogeography is a 'set of techniques and tools'; but it is not mean that neogeography is only set of techniques and tools and nothing else. Moreover, it is not mean that 'set of techniques and tools' is the necessary and sufficient condition for separating neogeography from ordinary maps and GIS. Intentional definition that provide set of necessary and sufficient conditions for differentiation between common cartography method, from one side, and neogeography, from another side, is highly demanded.

Core concept and main feature that separate Digital Earth (Google Earth) from classical map and GIS is an providing of multiscaling, or multiresolution, prohibited by the rules of cartography. This feature is most closely corresponding to concept of situational awareness, that emphasize 'the perception of elements in the environment within a volume of time and space' as a *sine qua non* condition for representation of complex dynamic processes in real world [Endsley, 1995].

Multi-resolution representation with same dataset for different scales is unachievable by the means of ordinary cartography, because of inevitable fragmentation of dataset into dissimilar scale-dependent replicas. Unique real world is inevitably broken down onto different models for different scales as a consequence of generalization, so direct interchange of geographical context and user data embed in this context between maps of different scales becomes impossible. It means maps and map-based products could not provide situational awareness.

Situational awareness principle strongly demands integration of 'vast quantities of geo-referenced data' into the same volume of space and time regardless of scale. In other words, situational awareness requires same geospatial context and same dataset for all scales. It is unachievable in classical cartography as a matter of principle, but Google Earth, as implementation of Digital Earth concept, meets this demand. It means Google Earth contradicts classical cartography principle. For understanding basic differences between cartography and Digital Earth we should provide classification of the variety of modern geospatial solutions.

USING OF DIGITAL EARTH FOR PEEX PROJECT

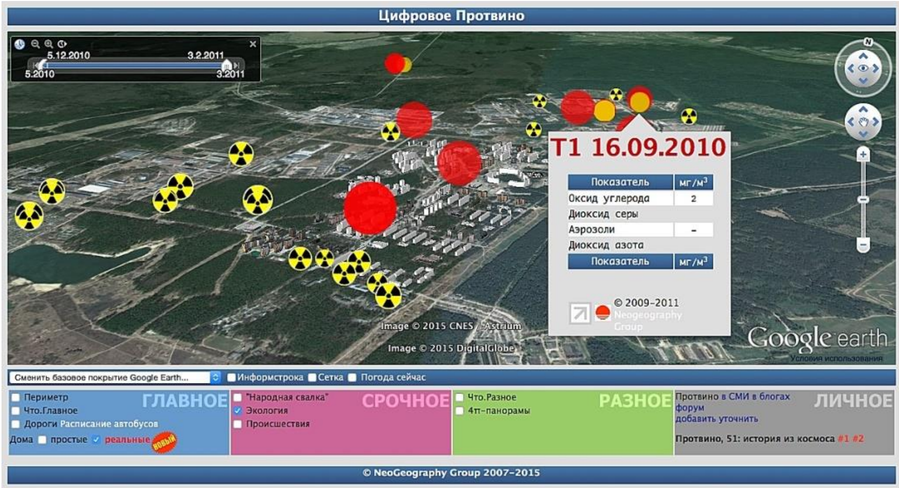
Success of PEEX as multiscal and multidisciplinary intitative depends on a quality of seamless integration of data from different scales. A particular problem is an aggregation of local data without loss of quality and accuracy in the same global ‘volume of time and space’. Local environmental data is an important source of information, because these data reveals most significant factors of pollutions. Also, we can predict a significant variability of environmental parameters within urban areas.

For accessing the efficiency of aggregating of different PEEX-related data with high accuracy the project ‘Digital Protvino’ can be used. Protvino is a small (near 40 ths. Inhabitants) town in Moscow Region, Russia. Digital Protvino (DE) is an intitative for creating municipal-level situational awareness by the means of neogeography tools with the help of aggregating heterogeneous data – social, ecological, medical, industrial, etc. The core of the project is a photorealistic 3D-model of a town buildings. This model is created and actualized for providing context-rich as a geographical framework for fast locating of data and providing situational awareness for decision making. Also, local information represented in the global geographical context could be seamlessly aggregating within continent-wide and global-wide information systems for providing scale-independent representation of dynamic processes.

Project Digital Protvino is accessible in the Internet (http://www.VProtvino.ru). Geographical context of the municipality is represented by the means of Google Earth API. Now the project covers the territory of Protvino municipality and aggregate different types of data:

- satellite imagery;
- 3D-models of buildings;
- social, business, transport, industrial infrastructures and POI;
- spherical panoramas;
- ecological data (in 4D-format);
- emergencies (in 4D-format).

Represented data is related to 2010-2011. It is possible to control 3D (spatial) and temporal dynamics interactively by the means of standard interface controls of Google Earth API. Heterogeneous dataset is integrated seamlessly within global context. Any data could be added in the project in the form of KML or KMZ files.



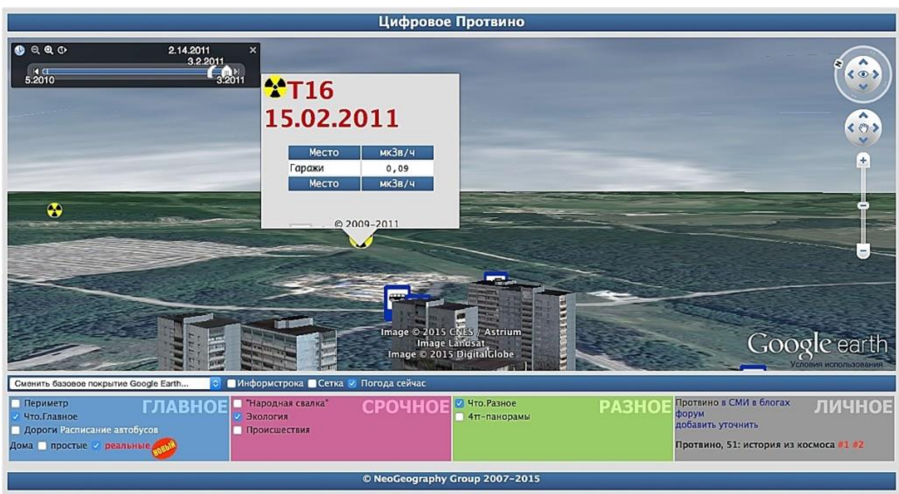


Figure 3, 4. Representation of environmental and ecological data in the Digital Protvino project.

Usually wide-scale aggregation of ecological and environmental data is provided by the means of two-dimensional geoportals. Using of Digital Earth approach seems more useful, because we can represent vertical distribution of parameters, especially in dense urban areas.

CONCLUSIONS

PEEX project as a global initiative for solving interlinked global challenges demands effective framework for aggregation data of different scales within same geospatial framework. Digital Earth is a most comprehensive approach up to date. Local initiative like Digital Protvino could be aggregated within PEEX project seamless and could provide significant information for the project.

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