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An Integrated and Adaptive Management Plan of the “Balta Mica a Brailei” Natural Park based on the Analytical Power of GIS Tools

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Abstract

More than ever in history, we must manage, preserve and restore our natural resources. In accordance to the European Union Environment policies, the main concerns are addressed by a continuous deterioration of natural habitats and the threats posted to certain species. Romania has also to ensure the establishment of Natura2000 network in accordance to the Birds and Habitats Directives and to prepare protection measures for the community interest sites. An appropriate management and monitoring system has to be developed and implemented by decision makers of the “Balta Mica a Brailei” Natural Park Administration. There is no simple answer to ensure these tasks, but during the project there is increasing optimism that the application of GIS and geoportal tools will allow them to make decisions to better conserve its resources and protect its biodiversity. This article is focused on the ability to use GIS technology as a tool to monitor habitat changes, track community interest species and predict future land and resource use that is essential to protect natural heritage and to maintain a favorable conservation status.

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1. Introduction

During the last years, Romania is in the process to implement a series of the Sectorial Operational Programme Environment projects that are focused on inventorying and mapping natural habitats and wild species of Community interest for the major natural protected areas. “Balta Mica a Brailei” Natural Park (BmB-NP) represents one of the

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most important protected areas where complex aquatic and terrestrial ecosystems are preserved in a state close to the original one. Across an area of 24.555ha, BmB-NP is declared in accordance to national and international legislation as: a) “*Natura2000 site*”: ROSCI006 [1] and ROSPA005 [2], at the European level; b) “*Natural Park*” [3] – natural protected area at the national level; and c) Wetland site of international relevance as a “*Ramsar site*” [4] at the global level.

Our research activities are conducted under the Sectorial Operational Programme Environment (SOP) – Priority Axis 4: “*Natural capital management of Balta Mica a Brailei through an integrated approach, assessment and awareness*” that takes place inside a complex program which aimed to create the “*Interpretation and management manual of the species and habitats*” at the end of 2013. This manual will include a national and biogeographical synthesis for each species and habitats of community interest, for the period 2007-2012, with a dual approach:

- Scientific (identification, conservation status, ecological synthesis) and
- Technical (including proposed management and conservation measures, evaluation of the impact of these measures).

1.1. Biodiversity of the studied area

Habitats – in terms of the European Directive “Habitats, Flora and Fauna” [5], there are identified 19 types of habitats in “Balta Mica a Brailei” Natural Park and 9 habitat types are found in Annex I of the aforementioned EU Directive. Habitats which are directly affected by this project implementation: 92A0 type of habitat - galleries of *Salix alba* and *Populus alba*, occupies 15% of the park and 91E0* (priority habitat) – water meadows of black poplar and ash with *Rubus caesius*, occupies 11% of the park area.

Birds fauna – are represented by 207 species (51% of the Romanian birds fauna) in accordance to “Balta Mica a Brailei” Natural Park database. A number of 68 species are included in Annex I of the European Birds Directive [6]. In 2008, “Balta Mica a Brailei” Natural Park is declared as ROSPA005 (Special Protection Area) for 26 species included in Annex I, Birds Directive and for 72 of migration species from the Bonn Convention Annexes. This protected area is very important for nesting populations of the following species: *Ardeide*, *Ciconia nigra*, *Aythya nyroca*, *Haliaeetus albicilla*. The localization of site along the Danube Delta – one of the largest rivers in Europe, makes it particularly important for migratory aquatic species such as ducks and geese which stop during the winter season.

Terrestrial fauna – in this area were identified other species of community interest which led to declare the BmB-National Park as SCI (Site of Community Interest) site. Among them, the following are mentioned: *Lutra lutra*, *Bombina bombina*, *Emys orbicularis*, and *Triturus dobrogicus*.

1.2. Main scientific activities of the project

The scientific activities conducted according to the project’s specifications are consisting of the following:

- Elaboration of the scientific studies, GIS mapping of the species distribution and proposed management measures for the following *species of community interest*: avifauna, ihtiofauna, reptiles and amphibians.
- Elaboration of the scientific studies, GIS mapping of the species distribution and proposed management measures for *terrestrial invertebrate species*: insects (including coleoptera, odonata, orthoptera), lepidopteres, terrestrial molluscs.
- Elaboration of the scientific studies, GIS mapping of the species distribution and proposed management measures for *aquatic invertebrates species*: crustaceans, molluscs and insects.
- Elaboration of the scientific studies, GIS mapping of the forest sites and meadows, and proposed management measures for *forest and shrubs habitats and meadows habitats*.
- Elaboration of the scientific studies for *aquatic habitats of community interest*, GIS mapping of the habitats and proposed management measures and
- The study of ecological relationships within aquatic, terrestrial and of ecoton ecosystems, integrated management measures proposed.

1.3. Scientific project results

Avifauna is represented by 86 species of which 19 species are listed in Standard form, of which 2 are Ciconiidae (*Ciconia ciconia*, *Ciconia nigra*), species which feed on amphibians, 6 Ardeidae (*Nycticorax nycticorax*, *Ardeola ralloides*, *Botaurus stellaris*, *Ixobrychus minutus*, *Casmerodius albus*, *Egretta garzetta*) whose main food resources are fish species.

In the field were identified 6 species of fish which are included in the standard list of ROSCI006 (*Alosa pontica*, *Aspius aspius*, *Pelecus cultratus*, *Cobitis taenia*, *Rhodeus sericeus amarus*, *Gymnocephalus schraetzer*), 1 specie included in Habitats Directive - Annex III (*Eudontomyzon mariae chiscar*), 1 specie in accordance to Government Order no. 462 (*Lota lota mihalţ*), which are potential sources of food for avifauna species.

As a potential source of food for the family Ciconiidae, there are 7 amphibian species: *Triturus dobrogicus*, *Lissotriton vulgaris* (*Triturus vulgaris*), *Bombina bombina*, *Hyla arborea*, *Bufo viridis*, *Pelophylax ridibundus* (*Rana ridibunda*), *Pelophylax esculentus* (*Rana esculenta*) and 2 reptiles: *Natrix natrix* and *Emys orbicularis*.

One of the potential sources of food for the insectivorous bird species are mentioned by existence of species protected under the EC Habitats Directive and Bern Convention, which are included also in Government Order no. 57/2007, on the group of Coleoptera, namely: *Bolbelasmus unicornis* (Scarabeidae, Geotrupinae), *Boros schneideri* (Boridae), *Buprestis splendens* (Buprestidae), *Carabus hampei*, *Carabus hungaricus*, *Carabus variolosus* (Carabidae), *Cerambyx cerdo* (Cerambycidae), *Cucujus cinnaberinus* (Cucujidae), *Graphoderus bilineatus* (Ditiscidae), *Lucanus cervus* (Lucanidae), *Morimus funereus* (Cerambycidae), *Oxyporus mannerheimi* (Staphilinidae, Oxyporinae), *Osmoderma eremita* (Scarabeidae, Cetoniinae), *Phryganophilus ruficollis* (Melandriidae), *Pilemia tigrina* (Cerambycidae), *Probatiscus subrugosus* (Tenebrionidae), *Pseudogauritina excellens* (Cerambycidae, Lepturinae), *Rhysodes sulcatus* (Carabidae, Rhysodinae), *Rosalia alpina* (Cerambycidae), *Stephanopachys substriatus* (Bostrichidae), as well as those of national interest, according to the same Government Order, namely: *Chrysobothrys leonhardi* (Buprestidae), *Scarabeus affinis* (Scarabeidae), *Brachyta balcanica*, *Pseudostrangalia verticalis* (Cerambycidae, Lepturinae), *Calchaenesthes oblongomaculata* (Cerambycidae, Purpurioninae), *Neodorcadion exornatum* (Cerambycidae), *Xylosteus spinolae spinolae* (Cerambycidae, Lepturinae), *Lycaena dispar* (Lycaenidae), *Apatura metis* (Nymphalidae).

For the aquatic insects, were identified individuals belonging to 6 species of the order Odonata (*Aeshna affinis*, *Orthetrum albistylum*, *Sympetrum vulgatum*, *Ischnura elegans*, *Ischnura pumilio*, *Sympecma paedisca*), one of which, *Sympecma paedisca*, is the first recorded in the Romanian fauna and is found in the EC Habitats Directive, Annex IV – Animal and plant species of community interest that requires strict protection. From the order Ephemeroptera were identified 2 species (*Cloeon dipterum*, *Caenis robusta*).

It was reported the presence of three species of molluscs (invertebrates) with special conservation status (*Theodoxus transversalis*, *Physa fontinalis*, *Anisus (Disculifer) vorticulus*, *Pseudanodonta complanata*).

None of these species of crustaceans are not found in annexes of the Government Order no. 57/2007. However, two types of amphipods (*Corophium* and *Dikerogammarus*) are important for biodiversity conservation on the Inferior Danube course, because according to campaign results Joint Danube Survey 2, species *Corophium curvispinum* and *Dikerogammarus villosus* are invasive species extremely harmful to native communities.

In addition to the above mentioned species with special conservation status, they represent important links in the food chains of the main categories of habitats and ecosystems of the “Balta Mica a Brailei” Natural Park. For most of them, such as species of fish, birds, amphibians, molluscs, insects, and so on, were made estimation of livestock population, parameters by which it was established the vulnerability of populations. Fortunately most groups are represented by populations in favorable conservation status and just fewer of them need special conservation measures.

Furthermore to the role of hosting a wide range of species with special conservation status, “Balta Mica a Brailei” Natural Park consists of a number of habitats types whose vegetation is different in structure with several capacities to achieve the ecological functions, for example the ability to fix and storage of various nutrients. The habitats were identified using the Braun-Blanquet method for vegetation inventorying [7]. In case of plants whose identification could not be done in the field our experts have taken samples that were studied in laboratory furthermore using determination instruments [8] and taking into consideration the existing scientific collection of plants at

the Herbarium of the Faculty of Forestry and Forest, Brasov. To develop the theoretical model related to capacity of assimilation and storage of nutrients, there have been mapped large units of vegetation (alluvial forest, tall grass habitats - *Typha* and *Phragmites*, lakes and temporary inland ponds). For each type of vegetation, our experts calculated the average values of biomass per unit of surface and nitrogen content per gram of dry substance. More detailed description of all these scientific results will be presented at the end of the project.

Considering all of these great scientific results together can be overwhelming, particularly when trying to make complex tradeoffs between them. This is where GIS technology is particularly valuable. GIS helped us to apply geographic knowledge to these scientific studies. The geographic approach often involves integrating many factors on a map and interpreting their meaning in a holistic way. The advent of GIS allowed us to use this type of approach for modeling the geography of natural habitats and species, observing and evaluating changes in biodiversity and more.

Using GIS technology, we had the ability to: a) develop and implement *BmB-NP geodatabase model*, b) create a dedicated *mobile GIS application* to collect and maintain geospatial data and attributes information by biologists, botanists, and other scientific experts, c) create *habitats and species distribution maps*, d) *publish geospatial information* and other resources *as web services* and d) develop *BmB-NP Geoportal application*. All of these state-of-art GIS tools allow us to monitor habitat changes, track community interest species and predict future land and resource use that is essential to protect natural heritage and to maintain a favorable conservation status in “Balta Mica a Brailei” Natural Park.

2. BmB-NP database model

BmB-NP enterprise geodatabase model is built to be open for data sharing and use and for interchange of data between GIS users and other systems. During the BmB-NP geodatabase design process [9], we focused on some common elements in GIS database design, such as:

- Series of thematic maps for habitats and species – a minimum series of geographic layers of information were specified for habitats and species distribution maps, which is part of the conceptual design steps.
- Common spatial representations – how each layer is represented as a collection of spatial datasets. Specific representations for each dataset were defined as a collection of points, lines, polygons, annotations, raster, attributes (tabular data), and so on.
- Minimum set of attributes describing features and integrated related tabular information.
- Integrity rules and spatial relationships – understanding the integrity specifications of a dataset is critical in assessing its suitability for a biodiversity application. Topology rules and networks were used to implement integrity rules and behavior.
- Map layout and map layer templates - BmB-NP enterprise geodatabase model includes the definition of common habitats and species distribution map products [10] and their associated map scales (1:15.000; 1:25.000 and 1:80.000).

During the conceptual design steps that help us to identify and characterize each thematic layer, we have ensured conformity with the guidelines of INSPIRE Data Specifications – Annex I: Protected sites [11], NATURA 2000 Standard Forms [12], and Species and Habitats Directives. Finally designed and developed, we have implemented BmB-NP geodatabase schema (see Fig.1), in order to centrally manage all geospatial resources regarding the biodiversity of the monitored protected area.

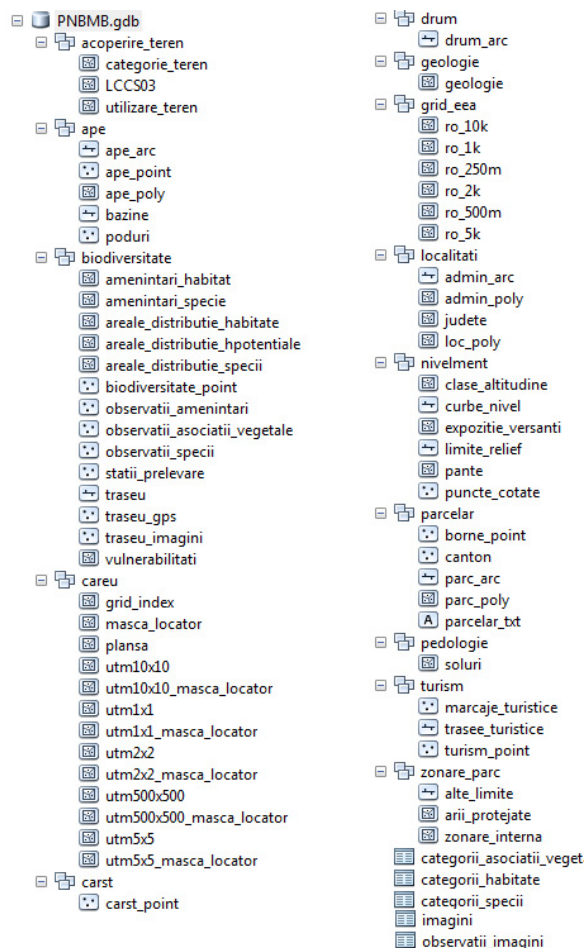


Fig. 1. BmB-NP Geodatabase Schema - physical model.

3. BmB-NP geoportal application

Geographic information is vital for any Park Administration to making sounds at the local, national, European and global levels. It is crucial in terms of addressing environmental, economic and social issues of pressing importance. Romania is also in the process of developing the National Spatial Data Infrastructure (NSDI) in response to INSPIRE Directive initiative launched in 2001. The primary objective of SDI is to maximize the overall use of geographic information that is held by a wide range of stakeholders in both public and private sectors.

“Balta Mica a Brailei” Natural Park Administration is subordinated to Ministry of Environment and Climate Changes, who plays also a central role as VicePresident of the NSDI Council in reviewing and testing the draft implementing rules and in assessing their potential impacts in respects to both costs and benefits. Because geoportal applications help to realize the objectives of NSDI to facilitate collaboration, they have been developed BmB-NP Geoportal as an important part of this. To support NSDI and BmB-NP activities, BmB-NP Geoportal represents an important and highly visible component of the local spatial data infrastructure, serving also as the “face” of NSDI [13]. Along with the development of our NSDI, we are working to promote the development of BmB-NP Geoportal at the European and international level.

BmB-NP Geoportal application [14] provides a *single point of access to geospatial data, web services, distribution maps, images, map catalogues and other geospatially related resources*. For example, see Fig. 2. As

gateway to geospatial information, BmB-NP Geoportal facilitates also geospatial information sharing between “Balta Mica a Brailei” Natural Park Administration, who own the information, and users (Scientific Council and Administrative Council of the BmB-NP administration, local authorities, academic institutions, non-government organizations, private sector, etc.), who needs the information. Users can browse or search through BmB-NP Geoportal to find relevant geospatial resources (ex. different habitats and species types, distribution maps, etc.) and evaluate them. Users can then download the online data, connect to and use the web services, and contact the BmB-NP Administration for offline data or other map documents.



Fig. 2. BmB-NP Geoportal application – web site interface.

3.1. BmB-NP Geoportal – resources content

BmB-NP Geoportal application facilitates the discovery and use of the following rich resources content:

- Map packages, including map documents (MXD files) along with associated data
- Layer packages, which are sets of data, plus renderers such as classification and symbolization scheme
- Framework datasets – incorporate topographic basemaps, orthoimagery, elevation, geology, hydrography, transportation, administrative units, protected area sites, hydrological constructions
- Operational layers (or thematic layers) – show items of natural habitats and wild species of community interest on top of a basemap in order to monitor the Favorable Conservation status
- Geospatial web services – ArcGIS for Server map services, image services, feature services
- Other documents– reports, map book of the habitats and species distribution maps (as pdf files).

BmB-NP Geoportal offers a variety of the geospatial web services from Online ArcGIS.com, ROEnv Geoportal application hosted by Ministry of Environment and Climate Changes, INIS GeoPortal managed by National Authority for Cadaster and Real Estate and other biodiversity geoportal applications (for example, see Fig. 3). All

these available web map services can be mashed up and allow users to make it easier, quicker and cheaper their own GIS application related to monitoring habitats and species of Community interest for the major natural protected areas.



Fig. 3. BmB-NP Geoportal application – “one-stop” to search data at other geoportals.

3.2. BmB-NP Geoportal – geospatial metadata

BmB-NP Geoportal with its centralized catalogue has all its geospatial metadata records contained in one catalogue. Geospatial metadata refers to the information that describes geospatial data, Web services, or other geospatial resources. Geospatial metadata published to the BmB-NP Geoportal geoportal catalogue includes the following elements: resource identification, quality and validity, spatial reference, temporal and distribution information. Metadata is useful in data archiving, assessment, management, discovery, transfer and distribution to users. The Inspire implementing guidelines are based on EN ISO 19115 (datasets) and EN ISO 19119 (services) for Commission Regulation (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata (2010). The Inspire ISO profile for datasets and services is fully supported by our BmB-NP Geoportal geoportal application (see Fig. 4).

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2007-2013
Investim in mediu. Credem in viitor.

Parcul Natural Balta Mica a Brailei

Home | Căutare | Răsfoire | **Administrație** | Viewer

Administrează | Adăugare

Vă rugăm să completați informațiile solicitate, cu privire la conținutul pe care doriți să îl publicați pe Geoportal. Vă rugăm să completați cât mai detaliat cu informații asupra conținutului.

Etichetele * Bold-Italic indică un element obligatoriu

☒ **10. Informații despre metadate**

Identificator fișier:

10.2 Data creării metadatei: (yyyy-mm-dd)

10.3 Limba metadatei:

Numele organizației:

Rolul organizației:

Adresa de e-mail:

☒ **1. Identificare**

1.1 Titlul resursei:

1.4 Adresa pentru localizarea resursei:

Tipul serviciului:

1.5 Identificatorul unic al resursei:

☒ **Browse Grafic**

Browse URL Grafic:

Browse Antet Grafic:

Browse Graphic Type:

☒ **3. Cuvânt-cheie**

Categoria de servicii de date spațiale ISO 19119:

☒ **Valoare cuvânt-cheie**

3.2 Originea vocabularului controlat:

3.1 Valoare cuvânt-cheie:

Tip:

Data de referință: (yyyy-mm-dd)

Fig. 4. BmB-NP Geoportal application – publishing metadata for habitats viewing service using Metadata editor (INSPIRE profile).

The centralized catalogue of BmB-NP Geoportal could sort the results consistently and conduct global searches in a very easy way. It is a very well designed and tuned, even with a huge volume of records can still achieve a very high performance. Another major advantage is offered by metadata catalogue for other participant providers that could published their metadata into the BmB-NP Geoportal via online metadata editor form, metadata XML upload, or metadata harvesting of XMLs in web folders.

3.3. BmB-NP Geoportal functionality

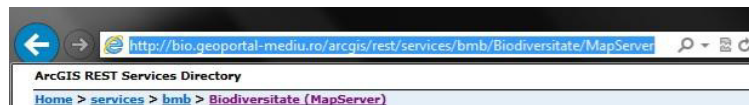
BmB-NP Geoportal application provides typical functionality suitable to each of three roles – *content provider* (publisher), *administrator* and *users*. Fundamental to their operation is the metadata catalogue which is managed in a centralized GIS architecture. *Publisher* provides content to BmB-NP geoportal and could create, publish and secure metadata. Its role includes registering metadata repositories to be harvested. *Administrator* manages accounts, metadata, resources content and security privileges of each group in the BmB-NP geoportal. *Users* can search and view metadata, search for the contents that meet their criteria, save their created maps, download data, and other more functionalities. They could also preview individual map services or create composite maps using the Flex-based map viewer.

Search functionality of the BmB-NP Geoportal is provided in a variety of ways. For example, users can perform

search functionality in the following ways (see Fig.5):



a)



b)

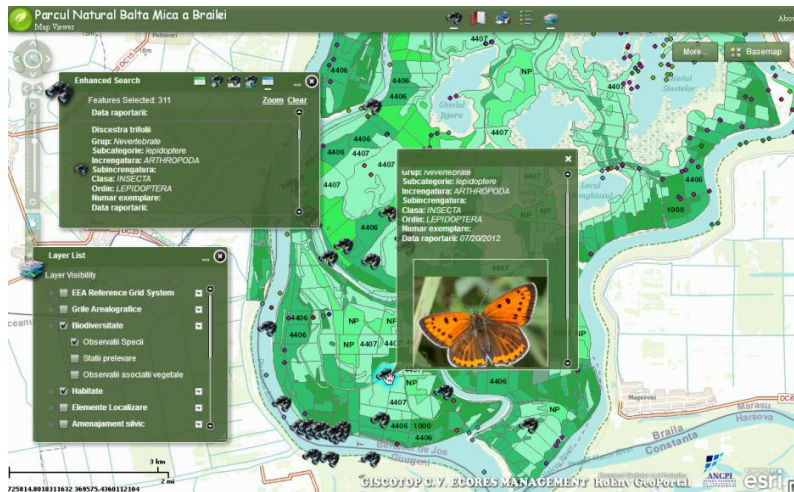


Fig. 5. BmB-NP Geoportal application provides search functionalities via (a) BmB-NP web site; (b) REST API interface and (c) a widget in its Flex-Map Viewer.

- Through BmB-NP Geoportal *web site*: they visit the geoportal web site, specify the search criteria and then review their search results.
- *Web browsers* quick search box without launching the BmB-NP geoportal web page.
- Through *REST API interface* that can return search results in HTML, KML, HTML fragments, ATOM, GeoRSS and JSON formats. These formats support a variety of other client applications.

- Using the Flex Map Viewer, widgets for HTML, or install plug-ins for ArcGIS for Desktop, and then search for geospatial resources directly in these clients.

4. Conclusion – the road ahead

The comprehensive management plan is considered by authorities as an operational instrument that set practical measures to achieve the conservation objectives for this site. Using our scientific research and technical results, “Balta Mica a Brailei” Natural Park Administration has the ability to:

- Indicate habitat types and species for which conservation measures are planned taking into consideration the information and results of the project activities.
- Identify the actual status of the habitat types and species and the desired status which should be reached through the conservation measures.
- Define a new strategy of the achievable conservation measures.
- Identify the necessary measures and a time schedule to meet those objectives.
- Increase the institutional capacity of the Natura 2000 network management by reviewing and completing a unitary and centralized enterprise database.
- Achieve a comprehensive monitoring system of habitats and species based on the latest GIS technology and
- Review and disseminate their management plan by evaluating each type of habitat, species or group of species of community interest, conservation status and to maintain its long term favorable status through habitats and species monitoring activities and by applying spatial geoportal and SDI technologies.

What is clearly necessary is a new approach, one that considers not just economic and political factors but also the ecological infrastructure that underpins our life support systems. Some suggest that we need to change how we live in our environment: reduce energy usage, cut CO₂ emissions, protect and restore natural areas, reduce our consumption, and stop polluting. As valuable as these individual activities are, it is clear that we also need a systematic and comprehensive framework for understanding and managing human activities as they relate to the environment. This approach needs to consider all the necessary factors for creating and maintaining a sustainable world. We do consider that our great scientific of project activities supported by GIS technology provides this powerful approach. It provides a new context for thinking and behaving, and for designing and creating solutions for our future.

Acknowledgements

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