Development of a Planning Information System to Support Environmental Planning in the Sultanate of Oman in the Frame of the Oman National Spatial Strategy

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1. Introduction

The Sultanate of Oman is located in the south of the Arabian Peninsula, with a total area of 309,500 km^2. It is bordered by the United Arab Emirates (UAE) to the northwest, Saudi Arabia to the west, and Yemen to the southwest. The coast is formed by the Arabian Sea on the southeast and the Gulf of Oman on the northeast. A vast gravel desert plain covers most of central Oman, with mountain ranges along the north (Al Hajar Mountains), where the country's main cities are located: the capital city Muscat, Sohar and Sur in the north, and Salalah in the south. Oman's climate is hot and dry in the interior, and humid along the coast (Scholz 1999).

According to the Census 2010 (MoNE 2011) Oman has a population of 2,7 Million, out of those 1,96 Million are Omanis. The population has grown from 2,3 Million since the Census 2003. More than 70 % of the population lives in urban areas. The population density is 9 persons/km^2; although the range in population density is very wide, from (according to Census 2003) 162 persons/km^2 in Muscat Governorate to 0,28 persons/km^2 in Al Wusta region.

In the past 30 to 40 years the country has undergone extreme changes in all aspects of economic development and improvements of quality of life. Oman hast benefited especially from the abundant oil and gas discoveries in the late 1960s showing a quadrupling of gross enrolment and literacy rates and a 27-year increase in life expectancy. In November 2010, the United Nations Development Programme listed Oman, from among 135 countries worldwide, as the nation most-improved during the preceding 40 years (UNDP 2010). Oman entered the 21 century experiencing an unprecedented pace of growth in development and economic opportunities. The nation gives more emphasis now on how to maintain and improve this performance and to ensure the achievements of sustainability by adopting policies and measures as stated in the long term development strategy – Oman 2020 (Committee for the Formulation of the Vision for Oman's Economy 1995).

As it is the case in all developing countries the rapid pace of growth has resulted in spatial imbalance and conflicting land uses due to improper allocation of land for development activities. The capital area being the major centre of financial, administration, employment, and social services is facing problems due to the rapid urban expansion resulted in limited land budgets and increasing level of traffic congestions. On the other hand, governorates and regions outside the capital area suffer from under-utilisation of their potential and resources. Due to this physical setting of the country and large geographical dispersion of the population, service delivery is a main challenge. Such situation resulted in continued migration from rural areas to the capital area and to urban centres within each region (SCTP 2008). In response to past and current spatial developments, issues and trends, the government of Oman has decided to conduct a national spatial strategy to deal with spatial aspects of socio-economic development aiming to achieve more balanced regional development by enabling all urban and rural areas to reach their potential regardless of its size and location.

Figure 1: Sultanate of Oman satellite image (source: google maps)

2. The Oman National Spatial Strategy

2.1 Goals – towards Sustainable Spatial Development

The Oman National Spatial Strategy (ONSS) is considered to be a systematic response to the government's intention to promote balanced regional development through a national spatial strategy that should bring (1) a better spread of job opportunities, (2) well educated and trained manpower, (3) a better quality of life, and (4) safe and healthy environment. ONSS intends to improve – on a sustainable basis – resources allocation and reduce social and economic inequalities by addressing – through an in depth investigation and analysis – all the issues concerning economic, social, and physical planning and implementation. In this context the objective of ONSS is to provide a solid framework for land use strategy that will ensure a sustainable socio-economic development at the national and regional levels and to propose specific policies conducive to the implementation of the proposed strategy in the light of the broad goals of the national long term strategy Oman Vision 2020 that are (1) continuance of economic growth and diversification, (2) ensure quality of life for Omani citizens through the provision of employment and improved social service and education, and (3) protection of the environment and natural resources. Furthermore ONSS shall define the way to improve the planning system to bring people together in the planning process, and to structure and feed their debate on the environmental, social, economic, and other issues of strategic decisions. Moreover it aims to improve the planning process and the quality of information used in the process. This means that transparency and good quality information are key principles. Hence, design and implementation of a data management strategy is an essential goal of ONSS to ensure strategic decisions are taken in the light of accurate data (SCTP 2008).

2.2 Main Activities

The Government of Sultanate of Oman has commissioned a team of international and national experts[i] to prepare the OMAN National Spatial Strategy. Subject of the ONSS is to analyse the current situation, to assess further development strategies and to draw-up the

national vision of spatial development, followed by proposals concepts, measures and instruments for implementation. The ONSS has a time perspective for the next 30 years, but also a mid-term horizon for 2020 and includes near-term objectives and high-priority measures for the next years.

The main activities and results to be expected by the ONSS process are to design the spatial planning strategy on the national as well as on the regional level, considering settlement structure, hierarchy and functions of settlements, potentials of economic areas and development sites, provision of social and technical infrastructure, preservation of natural resources and cultural heritage, prevention against natural hazards and environmental pollution, urban and rural development, etc.

In this context one task is to build the national Planning Information System. It provides spatial data as input for the planning process to analyse environmental as well as socio-economical, infrastructural and other spatial relevant developments, and to monitor the spatial development in the future.

A further activity is the assessment of the current institutional and legal planning framework and to propose procedures, regulations and instruments for spatial development and regulation (models of spatial governance).

ONSS aims to implement integrative and holistic planning approaches as well as specialised knowledge in different thematic fields which influence or are influenced by spatial development. These fields are: (1) Geographic Information Systems (GIS) and data management; (2) environment, natural resources, and cultural heritage; (3) population, human resources, social infrastructure; (4) economic sectors (agriculture, industries, services and tourism); (5) transport and mobility, technical infrastructure; (6) physical planning and land use; (7) institutional and legal affairs; and (8) capacity building. The ONSS process is communication and process oriented, which means to involve spatial actors and stakeholders on-site and to create knowledge networks in political-administrative, economic and academic fields. (ONSS 2012)

3. Environmental Aspects of ONSS

There is strong interest in the management of the environment since the environment affects all the society and the way people live. At the same time, human actions have tremendous impact on the environment. Population growth and the rapid pace of urban and industrial development put increasing pressure on the environment. Planning is about decision making regarding the use of land, and the wide ramifications of planning decisions are described with the following example: if plans require towns and cities to grow in compact ways and there is a bias against permitting single family houses to be built in the countryside for urban people, the commuting distances will be reduced with associated reductions in greenhouse gas emissions; biodiversity will be less threatened; water quality in countryside streams will be protected from inadequately maintained sanitation systems; and last but by no means least, significant cost savings will be made in the provision of essential services (Salvemini et al. 2011). The above example highlights facets of planning, namely, its role in the avoidance or reduction of negative effects such as environmental stress, waste of resources, inequalities, and its role in the support of quality of life, sustainability, and resilience of cities and regions. Therefore planning, as a public sector driven activity, tries to match the individual's needs with the society's ones. Sound planning which avoids the negatives and reaps the positives requires a strong, solid evidence base, which is itself built on good, relevant and up to date data and information, and useful tools which help to collect, analyse, model and monitor diverse spatial data and information in a rapid and efficient manner (Parker 1997; Schrenk et al. 2012; Salvemini et al. 2011).

Oman has undergone extreme changes within the last 40 years that have affected all factors of the environment: human beings, fauna, flora, habitats, soil, water, air, climate, landscape, material assets and cultural heritage. All these factors have to be addressed in the ONSS. Some of them are:

Currently environmental issues in Oman are mainly dealt within the context of nature conservation or nature protection. In this field extensive surveys and studies have been carried out over the last three to four decades. But until now, for example no systematic area wide base mapping, focussing on all the environmental aspects has been produced.

Growth of the Omani population to nearly three million inhabitants (including expats) up to now leads to an extensive use of water. Compared to other nations in the gulf region, Oman still has quite good groundwater reserves both in quantity and quality. But the intensification of agricultural production – Oman aims to produce 20% of the required agricultural goods in Oman – and a domestic water use that is more than three times higher than in central Europe put these reserves at risk.

The natural heritage – together with the cultural heritage – is one of the main driving forces of the tourism sector in Oman – it is a unique selling proposition (usp). Thus, a core issue in spatial consideration has to be nature and nature conservation. For that, the establishment of new and a sustainable management of all protected areas seems to be an adequate proposal.

Environmental impact assessments (EIA) are done now mainly on a project and not on a strategic level. Also the standards e. g. for threshold levels and assessment methods for the EIA in Oman have to be reviewed and improved. Out of this, issues to be tackled are basically structured as follows:

a. Biodiversity**:** This field deals with existing habitats (marine, coastal, terrestrial, freshwater, man-made, etc.), gives information about their spatial distribution and quality, indicates the degree of sensibility and identifies endangered as well as invasive species and their overall distribution, to the point of the *economic value of biodiversity* etc.
b. Impacts and hazards: This field includes all kinds of impacts and hazards on the environment, such as waste water disposal, climate change, human activities, pollution- and risk zones etc.
c. Policies, laws and strategies: In the context of environment various policies, laws (e. g. EIA) and strategies exist. Nevertheless, these (long-term) strategies, for the most part, lack spatial components. Within ONSS a link between environmentally relevant legal components and spatial reference need to be established. Further, management plans will be created to guarantee a goal-orientated implementation of these environmental strategies. The relationship between the environmental and physical planning strategies is pointed out.

Following data and information are required to describe the current environmental situation in Oman:

- Biodiversity hot spots/sensitive areas (marine/terrestrial/freshwater; important plant/bird areas etc.);
- Distribution of fauna and flora;
- Existing protected areas;
- “Red Lists” of endangered species;
- Existing plans and strategies, memberships in international programs;
- On-going projects (management, species-reintroduction, etc.);
- Research results (basic research, applied research, etc.);
- Emission sources causing air-, soil-, water- pollution;

- Risk zones (desertification, flood prone areas, hurricanes etc.);
- and others.

Concerning resources, non-renewable, that is mineral and fossil resources, and renewable ones have to be distinguished:

a. Mineral and fossil resources: Includes especially oil and gas, as well mineral resources of Oman. Amongst others, the spatial distribution, estimation of amount and applied extraction techniques are considered.
b. Renewable resources: In addition to renewable or partly renewable resources such as water, sunlight, wind, the scarce and precious resource water is of high interest. Further, the potentials for the use of solar and wind energy need to be estimated and other renewable resources reflected upon.
c. Soil: Although attended to the thematic subfield *agriculture* it has to be mentioned here as well, as one of the most important and delimited natural resource in Oman.

Following data and information will contribute to describe the status of natural resources in Oman:

- Estimation on the amount of fossil and mineral resources;
- Industrial sites, settlement areas, mines, quarries;
- Waste management (reuse, recycling etc.);
- Water supply data;
- Soil exploitation data;
- Existing strategies and on-going projects referred to renewable energies;
- Mineral/fossil resource data/maps;
- and others.

Decisions to be made for any land use, no matter if to built settlements, establish or intensify agricultural areas, establish technical infrastructure like roads and railways, or exploit the natural resources have to consider all environmental factors. The environmental aspects of ONSS, are an interdisciplinary, cross-sectional matter. Further do these aspects not only cross thematic borders, but also administrative ones, i. e. environmental planning requires cooperation between the local, regional, national and supranational levels. Challenges are to prevent incorrect planning e. g. for new settlements, and to avoid serious problems like lack of water-supply, waste-management, etc. generated by short-sighted, uncoordinated actions. ONSS intensively aims to establish the consideration of environmental issues as a cross-sectioned matter in spatial planning in Oman. In the interdisciplinary planning field, a unifying element can be the Planning Information System that, as a thread, sews together the different planning themes, geographic areas, stakeholders and administrative levels. Data, information and knowledge about what happens where, communication, coordination, alignment between the authorities and also with the stakeholders shall lead to a sustainable development of Oman and a wise use of the scarce resources.

4. The ONSS information system

4.1 Current Situation – from Information Islands to Information Systems

In the Sultanate of Oman there have been many past efforts and experience to implement and use Geographic Information Systems (GIS) for spatial analysis and planning for the last 20 years. Oman started to formulate the initial *GIS Implementation Strategy* in the late 1980s with the aim to define requirements, to improve data and information exchange between Oman Ministries, and to plan and introduce a National Land Information System on long term. Public authorities were equipped with comprehend GIS technology, and several efforts and work were done. The following years were characterised by several initiatives and studies on spatial data exchange between governmental authorities (Al-Awadhi 2002, Al-

Wardi 2010). *The Oman Vision 2020*, formulated in 1995, underlines to take up geospatial technology. In terms of water resources the vision emphasises the "(...) development of the information centre and hydrological information systems." (Committee for the Formulation of the Vision for Oman's Economy 1995, p. 95) Further the vision stresses "upgrading information systems and databases in government departments (...)" (p. 48-50). Realising the grand vision of transforming Oman into a sustainable knowledge based economy began with setting the economic vision for the Sultanate towards the year 2020 to which the *Digital Oman Strategy* contributes in terms of developing the Omani Digital Society and e-government (ITA 2002).

As a result of past activities organisational structure, human and technological resources, awareness and networks, and use of geographic information technologies for spatial analysis and decision-making are present to some extent. There have already been many impulses and initiatives, out of these some could be completed, whereas others could not, due to several reasons such as changes in policy, administrative structure and key stakeholders, budget constraints, and missing coordination.

Therefore current structures have characteristics of *information islands*, meaning that data is produced, stored and maintained decentralised in different organisations according to internal standards or no standards at all. There is a lack of coordination and data exchange between different organisations, but also between different departments within one organisation. The weak data flow leads to duplication of field activities and data redundancies. There is a lack of knowledge about what data is available in the country, due to poor metadata documentation. Human capacity is spread among different institutions with limited communication between institutions. As a consequence spatial planning can be characterised as sectoral with little integration. In practice it might happen that there are several plans for one piece of land, e. g. on the one side the piece of land is foreseen as agricultural land because of suitable soil; on the other side the piece of land is foreseen as an urban growth area.

Nevertheless, we have to keep in mind that the process to establish geographic information systems and spatial data infrastructures to support integrated planning activities is a long one that takes many years or even decades. To continue this process and to make advanced use of geographic information technology and spatial data in planning further efforts need to be done. In this regard, the *Oman Planning Information System* and the related *Capacity Building Programme* will aim to support Omani stakeholders to go one step further towards integrated planning processes and spatial decisions.

4.2 Goals of the ONSS Information System

The goal of the ONSS information system is to assess and monitor environmental, socio-economical, infrastructural and other spatial relevant regulations. The major principles of building Spatial Data Infrastructures will be used as a guideline within ONSS. As an example the definitions of the INSPIRE (Infrastructure for Spatial Information in the European Community) initiative can be used:

- Data should be collected once and maintained at the level where this can be done most effectively;
- It should be possible to combine seamlessly spatial data from different sources and share it between many users and applications;
- Spatial data should be collected at one level of government and shared between all levels;
- Spatial data needed for good governance should be available on conditions that are not restricting its extensive use (European Commission 2007).

Based on these major principles, the vision of the ONSS information system is to make geo-spatial information available and accessible in a *simple, practical, fast, and realistic* way for all planning purposes on all levels of public sector.

4.3 System Design

On the highest level, ONSS information system is grouped into three main systems: (1) Oman Planning Information System (OPIS), (2) Map Atlas, and (3) Monitoring System.

For the construction of the Oman Planning Information System, data requirements are defined, and data is collected from different sources and institutions (data providers). In a next step data is evaluated and quality checked according to defined quality criteria (accuracy, completeness, timeliness, metadata etc.), processed, compiled and integrated in one geodatabase. This includes transformation of data, establishment of data relationships, and assurance of topology rules, according to defined standards. To ensure semantic compatibility an ONSS thesaurus is introduced. The thesaurus helps to populate metadata with the right and precise terms and also supports a common comprehensive way of naming attributes and value domains.

In addition, existing strategies on national and regional levels as well as the new strategies and plans of ONSS are accounted for. OPIS builds the centre for every spatial data interaction throughout all participating parties. These are ministries, public, planners and decision makers who require one common base data. OPIS is managed by a central institution and several data stewards (Figure 2).

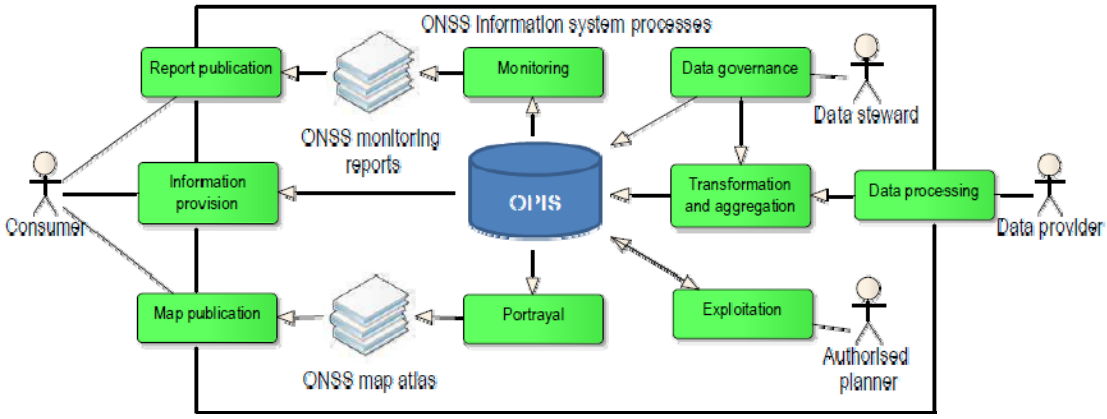

Figure 2: High level process view of ONSS information system

Data Stewards will be responsible for the data content, context, and associated business rules. This includes responsibilities for the data-integration processes by ensuring compliance to the data quality requirements representing the core part of “Geodata Governance”.

Authorised planners will use information from OPIS and enhance it, for instance by defining models in OPIS and thus generating new (modeled) information within the OPIS geodatabase. This process is bi-directional and can be called “exploitation”.

The ONSS Map Atlas is the visual output of the collected geographic information and comprises several styling and portrayal rules. It will be published via different visualisation technologies, adapted to the requirements and technical capabilities of the main user groups (acting as “consumers” of ONSS information) that are Omani authorities and institutional users, public users, and the education and research sector.

ONSS monitoring process provides the necessary functionality for creating reports that show the status of implementation of ONSS strategies and measures in reality. Whereas the Map Atlas represents the current spatial situation at one point of time, aim of the monitoring process is to observe spatial development over a certain period. With defined indicators changes can be detected, to further steer the planning process. Both the monitoring concept and Map Atlas are linked to the Oman Planning Information System that will on the one hand provide the required input data, and on the other hand will integrate new planning results.

4.4 Strengthening Capacities

Together with the ONSS information system a comprehensive GIS Capacity Building Programme is developed. GIS Capacity Building is defined as the strengthening of human resources, technological resources, awareness, networks and communication between stakeholders in the field of Geographic Information Systems and spatial data and information management for planning purposes.

Capacity building aims to support the use and maintenance of the planning information system by key stakeholders in Oman following the principle: *Maximise the strengths and minimise the weaknesses*. The goals of the capacity building program are (1) to raise awareness for the potential of GIS and new technologies in planning by presenting use cases and benefits, (2) to focus on how stakeholders can use and maintain the Oman Planning Information System, and (3) to support networks and communication between stakeholders through a train-the-trainer program, workshops, and conferences.

5. Conclusion

In planning there is a strong need for data and information. Especially there is a strong need for comprehensive, accurate, timely and relevant data and information. This is because of rapid growths and development, socio-economic changes, local, regional, national, international obligations, climate change, water scarcity, land degradation, energy resources, urban growth, etc. The aim of the Oman Planning Information System is to provide spatial data as an input for integrated planning activities as well as monitoring processes, to support a holistic planning approach, and finally the planning result. ONSS information system is a tool for decision making in environmental planning by encouraging cooperation between governmental bodies, educational institutions, and the private sector. Further the information system is a tool that supports the management of resources by increasing effectiveness in data management, productivity, more efficient data updating and the ability to compile and report information more rapidly. This planning tool makes required data and information accessible for spatial planning and monitoring purpose to support integrated and dynamic planning activities for a better management of Oman's environment and natural resources.

Endnote

[i] *Vienna University of Technology, Consatt Ltd., PRISMA solutions, CEIT Central European Institute of Technology, freiland CE ltd., IBV Fallast Transport Planning Consultancy*

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