ISSN: 2643-6876

DOI: 10.33552/CTCSE.2019.02.000539

Current Trends in Civil & Structural Engineering

Iris Publishers

Review Article

Prevention and Reduction of Geological and Environmental Problems in the Iranian Cities by Development of Geoscientific Knowledge-Base and Cyber-Infrastructure in the Urban Scale

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Received Date: April 04, 2019

Published Date: April 30, 2019

Abstract

Fast urbanization and growing urban areas pose great problems in water, energy waste, environment and geohazards of developing countries, as well as Iran. Many of these problems are related to issues that linked with geo-environmental constrains inside or around the cities directly or indirectly. urban geoscience in general and urban geology in particular are growing disciplines that provide essential knowledge for better understanding of geo environmental characteristics of urban areas in the large scales. The sound effectiveness of this knowledge requires the implementation of urban geoscientific cyber-infrastructures and knowledge-bases in the megacities. 3D-modeling, integration and other computational capabilities of modern days computing systems for huge amount of geospatial data in urban environment is an important and required tool to being prepared against challenges in the megacities as well as fast developing urban areas. This paper highlights major challenges of megacities in Iran that can be addressed by implementation of geoscientific cyber-infrastructure and knowledge-base.

Keywords: Big data; Knowledge-base; Urban geology; Megacities; Geoscience

Introduction

The fast urbanization has been continuing in many developing countries in world without required precautions in the long-term, considering the costs might appear in the future due to the fast urbanization [1]. Low attention to geological phenomena in the built environment is the source of many problems in near to mid-time in many cities and studies on geological aspects of urban environments is a major step to recognize and combat against the future problems [2-5]. Knowledge-based decision-making at all steps needs the accessibility and reliability of information and knowledge to be enhanced by establishment of collaborative cyber-infrastructures and ontologies for geosciences [6]. Based on last Population and Housing Censuses of Iran at 2016, more than 73% of people live in urban environments in Iran showing 2% growth of urban population than 2011 [7]. There is an increasing trend in number and dimensions of problems or crisis due to geological, environmental and climate-change phenomena in the urban populations of Iran during last decades [8-11]. This is more significant in ten megacities of Iran. This paper is of first attempts to the state of art of previous works done by governmental organization of IR Iran on implementation of national databases and information system for geosciences.

From Data to Knowledge in Geospatial and Geological Contexts

The DIKW hierarchy (Data, Information, Knowledge, Wisdom) was presented by Sharma [12] highlighting the first appearances of the hierarchy in both the knowledge management and information science domains [13] (Figure 2). In this hierarchy, computational methods play a major role in the initial processing of data to extract information, but they alone become less effective to compile knowledge from information [14]. Another form of representation of this concept is DIKW pyramid (Figure 2) that is more acceptable near information scientists [15] (Figure 1).

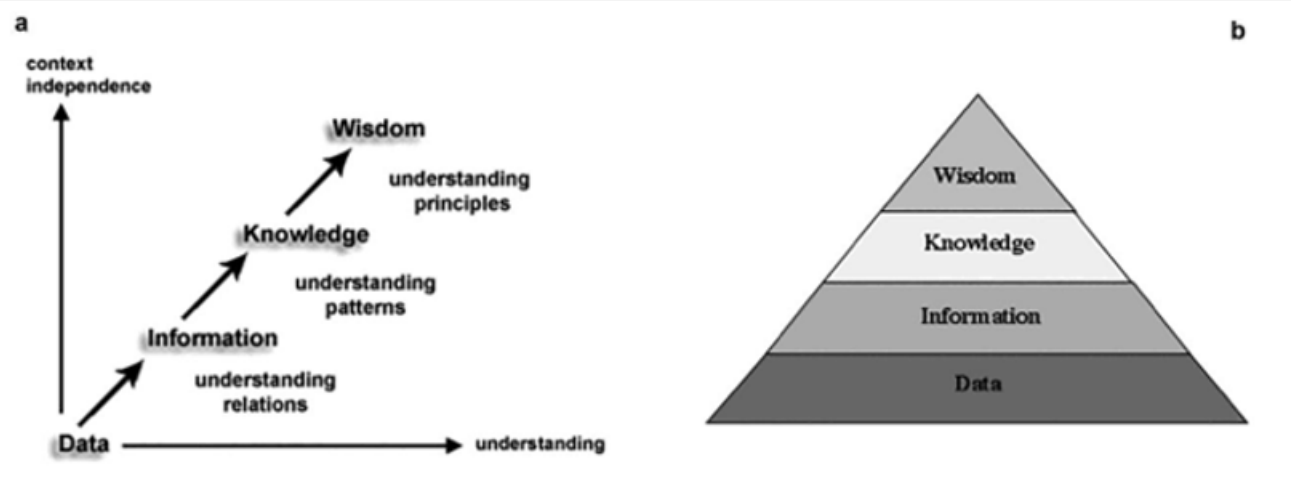

Figure 1: DIKW hierarchy (left) and DIKW pyramid (right).

According to Schreiber [16] and Nickols [17] geological knowledge can be categorized (Figure 2) as:

1. Explicit - knowledge that has been recorded, communicated or expressed in some sensible way;
2. Implicit – knowledge that is capable of being communicated or expressed, but is yet to be made explicit;
3. Tacit – knowledge that cannot be expressed but is obtained and exchanged by experience-based learning (Figure 2).

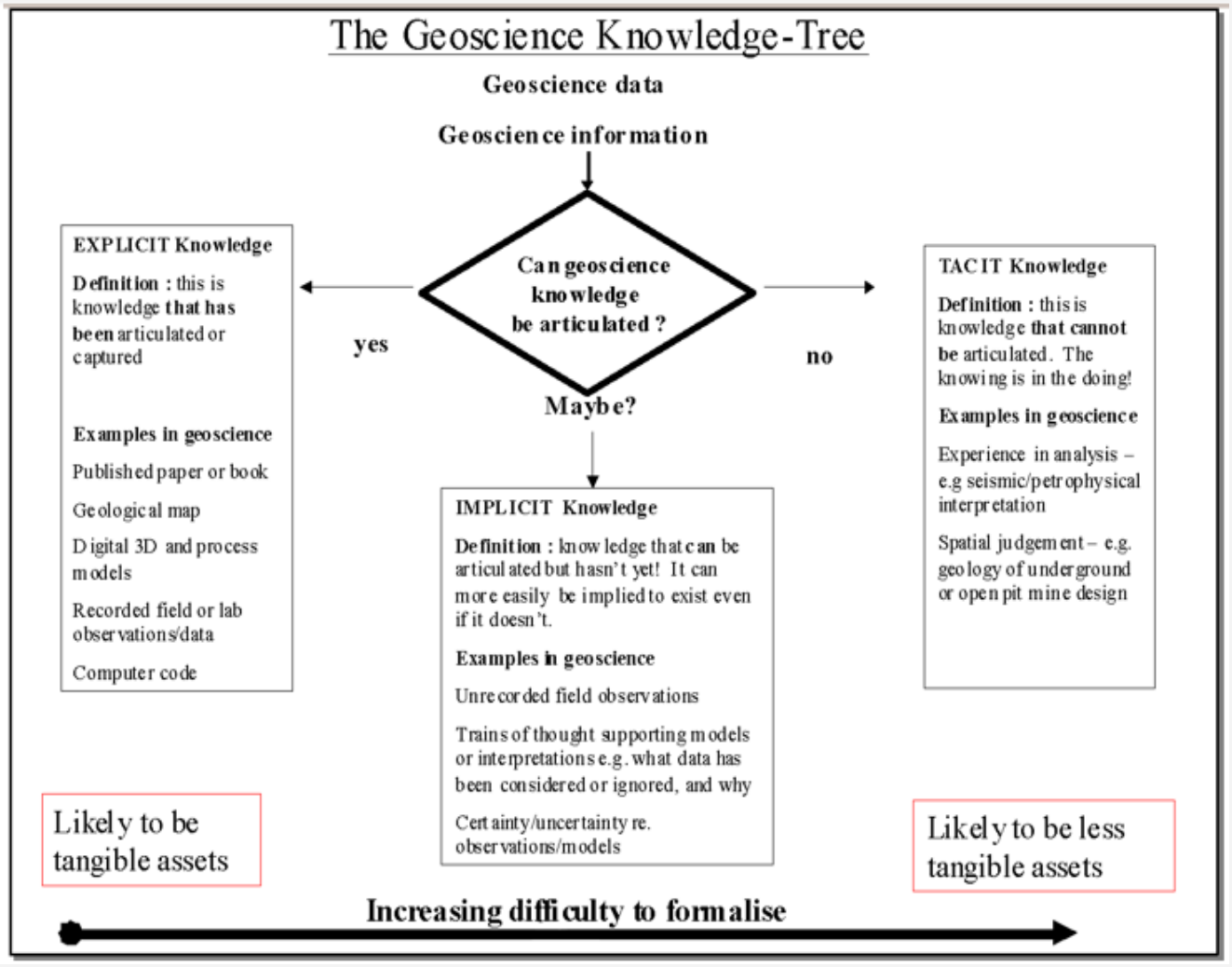

Figure 2: Definitions of explicit, implicit and tacit knowledge, with examples from geosciences (Modified from Howard et al. 2009).

State of Art of National Geospatial, Geological, Environmental Databases in Iran

The Producers of geological and geospatial data are completely diverse in size, subjects, occupation across the country. Beside the private sector acting on mineral industry, consulting engineers, geotechnical and civil division and so on; major, but not all, governmental organizations include Geological Survey of Iran, National Iranian Oil Company (NIOC), National Cartographic Center (NCC), National Geography Organization of Iran (NGOI), Ministry of Power, Ministry of Industry, Mine, Trade and many other ones. Among these organizations some have implemented relatively well-developed datacenters or spatial data infrastructures such as NCC, NIOC and NGOI. One the successful examples of implementation a national datacenter for geological and geospatial data and information by governmental organizations was started at 2001 in the Geological Survey of Iran entitled The National Geoscience Database of Iran (NGDIR). During 14 years of activity, the NGDIR was rare national database in the Middle East that put a vast effort on systematically implementation of geoscientific database on more than 20 topics including geological maps, earthquake, geotechnics, geochemistry, mines, etc. Many of databases were designed and implemented via getting advice or under direct conduction of top experts from various universities across the country. Unfortunately, and sadly, during recent years, due to less attention, management and financial issues the NGDIR has diminished to a great extent and has been forgotten. This not good for no one of us because of a great support for better research is and also better response to management needs to up to date information (Figure 3).

Figure 3: Infographic presentation of major geo-environmental problems and challenges of ten megacities of Iran.

Challenges for urban managers

Numerous studies discussed major problems in the urban environments of Iran (Figure 3) that include but not complete:

1. Waste management involving solid waste management [18], wastewater management [19], Medical wastes and hospital wastes [20]

2. Geohazard risk and crisis management involving urban flood management [39], earthquake hazard [22], surface fault rupture (e.g. Ehteshami-Moinabadi, 2015; 2016), land subsidence in urban areas [23-25]

3. Urban ecology [26] air pollution, voice pollution,

Transportation and traffic

These problems are highlighted due to management issues and some factors such as fragmentation of responsibilities and roles, multiplicity of actors, lack of inter-sectoral coordination and public participation [27]. Although these challenges are important

in Iran, but many of them also cause significant problems in other megacities around the world. For example, water resources management [28,29] and integrated water management in megacities [30] coastal megacities [31,32]; energy demand [33], environmental challenges [34], and natural disasters [35-37].

Discussion and Conclusion

Earth science and specially geology is the study of the Earth's structure and history. It supports the provision of resources to human populations and brings a wide range of essential services to them and industry and helps to understand how we can live sustainably on the Earth. The Earth is a dynamic planet with many dynamic phenomena and forces acting on land surface, water bodies, atmosphere and hundreds of kilometers below its crust. The fast urbanization in many developing countries in the world without required precautions, will intake considerable socioeconomic costs in the long-term [1]. Experiences from around the world recommend the development of geoscientific knowledge-base and cyber-infrastructure in the urban scale as tool to being prepared against challenges in the megacities as well as fast developing urban areas [38-45]. According to the previous practical developments of large scale geoscientific database in Iran, development of large-scale databases, knowledge-bases and cyber-infrastructures for megacities is an important tool as well as step for better managements of megacities that provides opportunities for interaction among various information, prediction of risks and estimation of damages due to scenario natural hazards, implementation of early warning systems in public areas and fast alarm system for urban managers, proving a basement for sub-surface 3D modeling of underground urban area and et cet. Understanding and modelling of urban environments by technological development of 3D city-scale ground models and our multi-thematic spatial datasets can be used across the environmental, planning and insurance sectors. These systems can address solutions for water-resource management, geohazard-resilience and planning challenges such as assessing ground conditions and risks to urban infrastructure [46]. Data types and information layers applicable for development of urban geoscientific data-infrastructures are defined in detail in Ehteshami-Moinabadi [47], Culshaw and Price [48] and Reeves [46]. There are some issues or challenges for implementation of such infrastructures that should be addressed before. Security issues, law conflicts [49,50].

Acknowledgement

None.

Conflict of Interest

No conflict of interest.

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