A Novel Approach to Position of Geographical Information System (GIS) and Geographical Information Management (GIM) in Water Resources Studies Using Satellite Photography

Naser Mohammadi Varzaneh[a,*], Alireza Vafaeinezhad[b]
[a]Department of Remote Sensing and Geographic Information System (GIS & RS), Science and Research Branch, Islamic Azad University, Tehran, Iran
[b]Faculty of Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran, Iran

Abstract— The necessity of considering water resources as base of economic infrastructures' development in developing societies such as Iran is largely emerged during recent years. The necessity of development and good management in facilities allocation and utilizing native potentials and knowledge of natural geography regions are among primary managing affairs of the country.Today, planning is accepted as the most effective tools for encountering with complex problems and representing key solutions in crisis management and facilities allocation. Comprehensive and complete knowledge about geographical field of the considered location and integrated, simultaneous analysis of all effective factors on the location are necessary for planning. Such knowledge and analysis requires applying system which can be able to store all location characteristics in a data bank and to represent these information as map and tabulated information according to the demands of planner.Geographical Information System (GIS) is recognized as one of the most effective planning tools in collecting, analysis and visual representation of required information for planning during recent decades. The current paper is aimed to investigate the role and position of this information system on various affairs of water resources' studies and its effects on the development of the country.

Index Terms— Water Resources, Planning Tools, Photogrammetry, Aerial Photos, Role of Photo, Map, Geographical Information System (GIS), Natural Geography Regions, Geographical Coordination, Water Resources' Management, Decision Support Systems (DSS), Geographical Information Management (GIM), Orbital Pattern Package, Sensors, Remote Sensing, Satellite Photography, Complex Digital Systems

1 INTRODUCTION

Planning for maintaining, exploitation and sustainable development of the existed water resources in various fields necessitate studying and knowing natural and human factors governing their situation [1–18]. Increasingly developments of human, especially during recent decades, on the field of technology, collecting information and map preparation are led to availability of a massive volume of information for managers and planners [19, 21, 23, 25 and 26]. Regarding the fact that this information will be valuable if they represent correctly at an appropriate time and location, the necessity of developing information banks in order to fast recover and obtain the required information as well as analysis of them is useful [19–29].

GIS, as a special and technical information base for collecting, storing, recovering, analyzing and representing information with geographical coordination, is a powerful and efficient tool in the fields of water resources' management [30, 31]. This system is of various applications in management and planning, investigations, researches and operational affairs [32–45].

GIS is an organized set of computer hardware and software, geographical information and expert people that is designed and developed in order to obtain, store, update, process, analyze and represent all forms of geographical information [46–56].

Some scholar researchers and scientists were firstly represented the idea of GIS. They were working with a huge volume of information about American and African forests as they were worked at an aerial photography company, and hence, they were thinking about using computer to solve their problems and finally, they were proposed the development of GIS to the government of the United States [57–73]. Regarding the fact that the United States was one of the most extensive and richest countries and its governors were knowing about dangers induced by devastation of water resources and were considered maintaining and using mineral and water resources, they were accepted the proposal and they were the manager of GIS operation in the United States [74–79].

After 1975, reduction of software cost and development of microprocessors were led to a revolution in this field and largely motivated governments, private sectors and universities to utilize the system. For example, in 1985, about 1000 GIS were operated only in one of the USA states and it is anticipated that millions of people will use GIS in future years [80–85].

- [a,*]*Naser Mohammadi Varzaneh, Corresponding Author, M.S. of Geographic Information System (GIS), Department of Remote Sensing and Geographic Information System (GIS & RS), Science and Research Branch, Islamic Azad University, Tehran, Iran.*
- [b]*Alireza Vafaeinezhad, Ph.D. in Geospatial Information System (GIS), Assistant Professor, Faculty of Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran, Iran.*

2 Results and Discussion

In GIS, various information of a region store in information bank as various layers. The most important advantage of this system is that it can superimpose information layers for various applications and or performs various analyses as relation functions between layers.

Generally, information of GIS can be divided into two groups:

(a) Location or graphical information: This information, which also named as spatial information, shows the location of topographies. For instance, a point with a given coordination (x, y) shows the location of a hole on the map.

(b) Non–location or attributive information: This information describes the characteristics of location topography which defined in graphical information. For example, various information such as depth, owner and diameter attribute to a hole that is defined with a point.

GIS can answers to the following questions:

(a) Questions about a location; what is existed in a given location?

This is the first question which can be answered by GIS. A location can be defined by various methods in the system such as with name and geographical characteristics code (longitude and latitude).

(b) Conditional questions; finding a location with a given condition.

This question is the converse of the first one in which, the characteristics of a given location are identified. According to this question, however, the goal is finding a location with a given characteristic. To answer this question, spatial analysis is necessary. For example, find a region with no forest, having at least one hectare area, located at 100 (m) distance from the road and having an appropriate soil condition for construction activities. In this question, four major conditions are represented which are the representatives of all considered conditions.

(c) Process investigation; how a given location or level is varied from past until now?

In fact, this question is a combination of two previous questions; i.e., system must find locations that are changed during a given period (condition). In other words, combining the question of given location and condition (variation) which is questionable with storing map information of a region during two different periods.

(d) Pattern; what is the type of spatial pattern?

This is a very complex question. For example, it can be asked that if cancer is the major factor of death among residents of regions neighboring to a nuclear power plant? In this regard, various questions can be asked depend on type of system and its application so that system can answer to them.

(e) Modeling; what would be question if?

This question is mainly related to planning as well as the effects of operation of plans. For example, what would be the effects of road construction on the environment? Answering to such questions is depend on the availability of a set of geographical information that are appropriately collected, stored, maintained and organized so that this set of information can be used in various conditions.

(f) Decision Support Systems (DSS);

In fact, all previous abilities can be summarized in the last one. The most important ability of GIS is increasing the potential for decision making and planning for managers and planners of the society. Due to widely use of GIS and increasingly applying of it in managing affairs and even high levels of country planning, GIS is named as GIM (Geographical Information Management).

Today, by increasingly developing of remote sensing and aerial photography, applications of remote sensing and GIS for environmental planning, especially in various fields of natural and geological sciences are increasingly developed.

In the current paper, the role and application of satellite photography in environmental and water resoureces studies are investigated. GIS can be considered as a high level map product.

In recent years, the term "Geographical Information System" is equally used as fast emerging technology for spatial data processing. GIS can be defined as a powerful set of computer tools for collecting, storing, recovering, transferring and illustrating spatial data from real world to use for special purposes.

Preparation of geological maps including recognition of the form of earth, types of rock and rock structure such as fissures, faults and folding as well as illustration of geological units and structure on a map or including other illustration in the correct spatial relationship between them. Exploration of mineral resources is one of the important activities about preparation of geological maps.

Most information about potentially mineral regions can be obtained by interpreting surficial topography over aerial photos and satellite images. Multi–level interpretation of image is frequently used in geological investigations. For instance, various factors help to explore the lines induced by fractures and faults and natural linear phenomena of the earth. One of their most important is angular relationship between linear topography and light emission source.

It is rarely possible to make a positive interpretation about the type and concentration of a pollutant only based on aerial photo. However, it may be possible to determine the entrance point of water to lake and characteristics of general distribution of pollution based on interpretation of aerial photo. In some cases, such as suspension of sediments in the water, photo can be interpreted using investigation of emissions along with experimental analysis. Pollution induced by sediments is frequently observable on the aerial photos. Since reaction spectral pattern of suspended particles can be distinguished from natural water of lake, these particles can be easily recognized on the aerial photos. When concentrated resources of pollution such as industrial and local wastes enter to the natural water body, feather–like diffusion is typically seen. If wastes have different reflective characteristics from water body, mixing and diffusion of them can be seen on the aerial photo. Materials, such as oil, that create film layers on the water surface can be observed through aerial photography. Huge oil leaks are brown or black and thinner layers are brilliant silver or have a color band like rainbow spectrum. The main reflective differences between water bodies and oil layers are happened in photo section of spectrum between 0.25 and 0.55

micrometer. Aerial photography can help for determining leak regions and losses imparted to the natural and artificial components of river environment.

Satellites repeatedly prepare information for planners. Orbital pattern package of satellite represents the available sensors on the repeated images from the same points or all points of ground surface. These values can be varied from an image per 10 minutes as a band from ground surface not entire earth to complete coverage of earth for five or ten times per day. This situation is vital for various trends that are considered as active pattern. Soil erosion, variations of product amount as the characteristic of grow up season, development as application of irrigation or application of nitrate fertilizer, effects of flood or drought, risks of spontaneous firing or even variation of ground application and ground coverage over years are examples of this case.

In past, these subjective maps and environmental indices have been obtained through traditional field studies. In recent years, however, these are prepared using complex digital systems based on remote sensing. In fact, remote sensing is used for describing information from a considered target without physical contact with it. Other advantages of remote sensing are its special performance on combining and processing various subjects such as height, urban area, river positions, plant cover maps, etc.

Ground application is related to human activities or activities related to a specific piece of ground. While the information related to ground coverage is directly obtained from remote sensing images, information related to ground application type cannot always directly obtain from ground coverage. For example, recreational activities that widely cover a large part of the ground cannot be evaluated through satellite images and aerial photos. To investigate hydrological characteristics of flood induced by rainfall, knowing about the amount and distribution of ceilings, weeds, sidewalks and trees in the considered region is important and hence, knowledge of ground application and ground coverage can be important for ground planners and ground activities managers.

However, there are numerous categorizing criteria for ground application and it causes that there is not a unique definition for evaluation of aerial photos regarding ground application studies. For explaining ground coverage, paying attention to digital data obtained from photos and images and converting these data to image systems of map is important.

Categorization of agricultural product type are performed through aerial photos and based on previous assumption that specific types of plants can be recognized using reaction of spectral patterns and their photo tissue.

- Determining the progress of plowing and cultivation, regions with high and low drainage, and problems induced by erosion and drainage.
- Searching for insects, plant diseases, lack of cultivation induced by incorrect human performance, determining treatment indices.
- Controlling the natural growing and improving through growing season.
- Controlling the position conditions and extensions required for harvesting.
- Determining total plowing area and controlling the ground coverage in plowed regions.
- Documenting special conditions such as flloding, drought, freezing, firing, typhoons, shower, hail and other problems.

3 Conclusion

Aerial photos can be interpreted for estimation of population, building quality assessment, traffic and parking investigations, location selection processes, identification of urban variations, and more important than previous ones, recognizing the applications of urban grounds. Interpretation of aerial photos can be useful in investigations about traffic and parking.

Determining the basin regions of groundwater as well as estimating the applications of groundwater based on interpretation, type of plant, region and irrigation type is among applications of GIS. Continuous photos at various times can show flooding induced by river and its consequences.

Interpretation of aerial photos and photogrammetry is very useful in collecting various natural and artificial data related to topography, geology, water resources, soils, construction materials, growing, ground application, position of fecund grounds, historical/ancient regions and natural unexpected events such as earthquake, land sliding, floods, volcano, and tsunami.

References

[1] Madjid Tavana, Weiru Liu, Paul Elmore, Frederick E. Petry, Brian S. Bourgeois, A practical taxonomy of methods and literature for managing uncertain spatial data in geographic information systems, Measurement, Volume 81, March 2016, Pages 123-162.

[2] Huanyu Wu, Jiayuan Wang, Huabo Duan, Lei Ouyang, Wenke Huang, Jian Zuo, An innovative approach to managing demolition waste via GIS (geographic information system): a case study in Shenzhen city, China, Journal of Cleaner Production, Volume 112, Part 1, 20 January 2016, Pages 494-503.

[3] Carlos Fernández-Caramés, F. Javier Serrano, Vidal Moreno, Belén Curto, J.F. Rodríguez-Aragón, Raúl Alves, A real-time indoor localization approach integrated with a Geographic Information System (GIS), Robotics and Autonomous Systems, Volume 75, Part B, January 2016, Pages 475-489.

[4] Giovanni Ottomano Palmisano, Kannan Govindan, Rosa V. Loisi, Pasquale Dal Sasso, Rocco Roma, Greenways for rural sustainable development: An integration between geographic information systems and group analytic hierarchy process, Land Use Policy, Volume 50, January 2016, Pages 429-440.

[5] Kuo-Chih Hung, Mohsen Kalantari, Abbas Rajabifard, Methods for assessing the credibility of volunteered geographic information in flood response: A case study in Brisbane, Australia, Applied Geography, Volume 68, March 2016, Pages 37-47.

[6] Adam Drewnowski, Anju Aggarwal, Andrea Cook, Orion Stewart, Anne Vernez Moudon, Geographic disparities in Healthy Eating Index scores (HEI–2005 and 2010) by residential property values: Findings from Seattle Obesity Study (SOS), Preventive Medicine, Volume 83, February 2016, Pages 46-55.

[7] Norm D. Smith, Sandip M. Prasad, Amit R. Patel, Adam B. Weiner, Joseph J. Pariser, Aria Razmaria, Chieko Maene, Todd Schuble, Brandon Pierce, Gary D. Steinberg, Bladder Cancer Mortality in the United States: A Geographic and Temporal Analysis of Socioeconomic and Environmental Factors, The Journal of Urology, Volume 195, Issue 2, February 2016, Pages 290-296.

[8] S. Cavazzi, A.G. Dutton, An Offshore Wind Energy Geographic Information System (OWE-GIS) for assessment of the UK's offshore wind energy potential, Renewable Energy, Volume 87, Part 1, March 2016, Pages 212-228.

[9] Erica L. Nelson and P. Gregg Greenough, Chapter 49 - Geographic Information Systems in Crises, In Ciottone's Disaster Medicine (Second Edition), edited by Gregory R. Ciottone, Elsevier, Philadelphia, 2016, Pages 312-316.
[10] Daniela Bertoldi, Alice Barbero, Federica Camin, Augusta Caligiani, Roberto Larcher, Multielemental fingerprinting and geographic traceability of Theobroma cacao beans and cocoa products, Food Control, Volume 65, July 2016, Pages 46-53.
[11] Steffen Schmitz-Valckenberg, José-Alain Sahel, Ronald Danis, Monika Fleckenstein, Glenn J. Jaffe, Sebastian Wolf, Christian Pruente, Frank G. Holz, Natural History of Geographic Atrophy Progression Secondary to Age-Related Macular Degeneration (Geographic Atrophy Progression Study), Ophthalmology, Volume 123, Issue 2, February 2016, Pages 361-368.
[12] Chunxiao Zhang, Min Chen, Rongrong Li, Chaoyang Fang, Hui Lin, What's going on about geo-process modeling in virtual geographic environments (VGEs), Ecological Modelling, Volume 319, 10 January 2016, Pages 147-154.
[13] Jinfang Jiang, Guangjie Han, Hui Guo, Lei Shu, Joel J.P.C Rodrigues, Geographic multipath routing based on geospatial division in duty-cycled underwater wireless sensor networks, Journal of Network and Computer Applications, Volume 59, January 2016, Pages 4-13.
[14] Alexander M. Brown, Lars Bejder, Guido J. Parra, Daniele Cagnazzi, Tim Hunt, Jennifer L. Smith, Simon J. Allen, Chapter Ten - Sexual Dimorphism and Geographic Variation in Dorsal Fin Features of Australian Humpback Dolphins, Sousa sahulensis, In: Thomas A. Jefferson and Barbara E. Curry, Editor(s), Advances in Marine Biology, Academic Press, 2016, Volume 73, Pages 273-314.
[15] J.A. Jiménez Capilla, J. Arán Carrión, E. Alameda-Hernandez, Optimal site selection for upper reservoirs in pump-back systems, using geographical information systems and multicriteria analysis, Renewable Energy, Volume 86, February 2016, Pages 429-440.
[16] Holly Kramer, Orlando M. Gutiérrez, Suzanne E. Judd, Paul Muntner, David G. Warnock, Rikki M. Tanner, Bhupesh Panwar, David A. Shoham, William McClellan, Waist Circumference, Body Mass Index, and ESRD in the REGARDS (Reasons for Geographic and Racial Differences in Stroke) Study, American Journal of Kidney Diseases, Volume 67, Issue 1, January 2016, Pages 62-69.
[17] Kiril M. Dimitrov, Andrew M. Ramey, Xueting Qiu, Justin Bahl, Claudio L. Afonso, Temporal, geographic, and host distribution of avian paramyxovirus 1 (Newcastle disease virus), Infection, Genetics and Evolution, Volume 39, April 2016, Pages 22-34.
[18] Hugo De Groote, Francis Oloo, Songporne Tongruksawattana, Biswanath Das, Community-survey based assessment of the geographic distribution and impact of maize lethal necrosis (MLN) disease in Kenya, Crop Protection, Volume 82, April 2016, Pages 30-35.
[19] Zhenxing (Eddie) Mao, Yang Yang, FDI spillovers in the Chinese hotel industry: The role of geographic regions, star-rating classifications, ownership types, and foreign capital origins, Tourism Management, Volume 54, June 2016, Pages 1-12.
[20] Víctor Adrian Pérez-Crespo, Ismael Ferrusquía-Villafranca, Víctor Manuel Bravo-Cuevas, Pedro Morales-Puente, José E. Ruiz-González, Dietary analysis of Late Cenozoic Mexican equids from three different geographic/geologic settings using stable carbon isotopes: Coincidences, differences and paleobiologic significance, Journal of South American Earth Sciences, Volume 66, March 2016, Pages 97-109.
[21] Camila Maione, Bruno Lemos Batista, Andres Dobal Campiglia, Fernando Barbosa Jr, Rommel Melgaço Barbosa, Classification of geographic origin of rice by data mining and inductively coupled plasma mass spectrometry, Computers and Electronics in Agriculture, Volume 121, February 2016, Pages 101-107.
[22] Silvia Torresan, Andrea Critto, Jonathan Rizzi, Alex Zabeo, Elisa Furlan, Antonio Marcomini, DESYCO: A decision support system for the regional risk assessment of climate change impacts in coastal zones, Ocean & Coastal Management, Volume 120, February 2016, Pages 49-63.
[23] O. Unsalan, A.H. Kuzucuoglu, Effects of hazardous pollutants on the walls of Valence Aqueduct (Istanbul) by Raman spectroscopy, SEM–EDX and Geographical Information System, Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Volume 152, 5 January 2016, Pages 572-576.
[24] Heather E. Danysh, Kai Zhang, Laura E. Mitchell, Michael E. Scheurer, Philip J. Lupo, Maternal residential proximity to major roadways at delivery and childhood central nervous system tumors, Environmental Research, Volume 146, April 2016, Pages 315-322.
[25] Jeroen Buters, Marje Prank, Mikhail Sofiev, Gudrun Pusch, Roberto Albertini, Isabella Annesi-Maesano, Celia Antunes, Heidrun Behrendt, Uwe Berger, Rui Brandao, Sevcan Celenk, Carmen Galan, Łukasz Grewling, Bogdan Jackowiak, Roy Kennedy, Auli Rantio-Lehtimäki, Gerald Reese, Ingrida Sauliene, Matt Smith, Michel Thibaudon, Bernhard Weber, Lorenzo Cecchi, Variation of the group 5 grass pollen allergen content of airborne pollen in relation to geographic location and time in season, Journal of Allergy and Clinical Immunology, Volume 136, Issue 1, July 2015, Pages 87-95.e6.
[26] Anne Sjoerd Brouwer, Machteld van den Broek, Özge Özdemir, Paul Koutstaal, André Faaij, Business case uncertainty of power plants in future energy systems with wind power, Energy Policy, Volume 89, February 2016, Pages 237-256.
[27] Sara Marchionni, Antonella Buccianti, Andrea Bollati, Eleonora Braschi, Francesca Cifelli, Paola Molin, Maurizio Parotto, Massimo Mattei, Simone Tommasini, Sandro Conticelli, Conservation of 87Sr/86Sr isotopic ratios during the winemaking processes of 'Red' wines to validate their use as geographic tracer, Food Chemistry, Volume 190, 1 January 2016, Pages 777-785.
[28] Marco F. Ortiz-Ramírez, Michael J. Andersen, Alejandro Zaldívar-Riverón, Juan Francisco Ornelas, Adolfo G. Navarro-Sigüenza, Geographic isolation drives divergence of uncorrelated genetic and song variation in the Ruddy-capped Nightingale-Thrush (Catharus frantzii; Aves: Turdidae), Molecular Phylogenetics and Evolution, Volume 94, Part A, January 2016, Pages 74-86.
[29] Frederick R. Kates, Ramzi G. Salloum, James F. Thrasher, Farahnaz Islam, Nancy L. Fleischer, Wasim Maziak, Geographic Proximity of Waterpipe Smoking Establishments to Colleges in the U.S., American Journal of Preventive Medicine, Volume 50, Issue 1, January 2016, Pages e9-e14.
[30] Jan Tomaschek, Ralf Kober, Ulrich Fahl, Yuriy Lozynskyy, Energy system modelling and GIS to build an Integrated Climate Protection Concept for Gauteng Province, South Africa, Energy Policy, Volume 88, January 2016, Pages 445-455.
[31] E. Comino, V. Ferretti, Indicators-based spatial SWOT analysis: Supporting the strategic planning and management of complex territorial systems, Ecological Indicators, Volume 60, January 2016, Pages 1104-1117.
[32] Eren Özceylan, Mehmet Erbaş, Mert Tolon, Mehmet Kabak, Temel Durğut, Evaluation of freight villages: A GIS-based multi-criteria decision analysis, Computers in Industry, Volume 76, February 2016, Pages 38-52.
[33] Si-jing Ye, Tai-lai Yan, Yan-li Yue, Wei-yan Lin, Lin Li, Xiao-chuang Yao, Qin-yun Mu, Yong-qin Li, De-hai Zhu, Developing a reversible rapid coordinate transformation model for the cylindrical projection, Computers & Geosciences, Volume 89, April 2016, Pages 44-56.
[34] Si-jing Ye, Tai-lai Yan, Yan-li Yue, Wei-yan Lin, Lin Li, Xiao-chuang Yao, Qin-yun Mu, Yong-qin Li, De-hai Zhu, Developing a reversible rapid coordinate transformation model for the cylindrical projection, Computers & Geosciences, Volume 89, April 2016, Pages 44-56.
[35] Zaixing Wu, Zhiming Yu, Xiuxian Song, Yanfeng Li, Xihua Cao, Yongquan Yuan, A methodology for assessing and mapping pressure of human activities on coastal region based on stepwise logic decision process and GIS technology, Ocean & Coastal Management, Volume 120, February 2016, Pages 80-87.
[36] Celia O'Hare, Vincent O'Sullivan, Stephen Flood, Rose Anne Kenny, Seasonal and meteorological associations with depressive symptoms in older adults: A geo-epidemiological study, Journal of Affective Disorders, Volume 191, February 2016, Pages 172-179.
[37] R. Paciello, I. Coviello, P. Bitonto, A. Donvito, C. Filizzola, N. Genzano, M. Lisi, N. Pergola, G. Sileo, V. Tramutoli, An innovative system for sharing, integration

and visualization of heterogeneous 4D-information, Environmental Modelling & Software, Volume 77, March 2016, Pages 50-62.
[38] Rebecca Bundschuh, Ulrike Kuhn, Mirco Bundschuh, Caroline Naegele, David Elsaesser, Ulrich Schlechtriemen, Bernadette Oehen, Angelika Hilbeck, Mathias Otto, Ralf Schulz, Frieder Hofmann, Prioritizing stream types according to their potential risk to receive crop plant material — A GIS-based procedure to assist in the risk assessment of genetically modified crops and systemic insecticide residues, Science of The Total Environment, Volume 547, 15 March 2016, Pages 226-233.
[39] Bahareh Inanloo, Berrin Tansel, Kollol Shams, Xia Jin, Albert Gan, A decision aid GIS-based risk assessment and vulnerability analysis approach for transportation and pipeline networks, Safety Science, Volume 84, April 2016, Pages 57-66.
[40] Heng Tsai, Zeng-Yei Hseu, Hung-Yu Kuo, Wen-Shu Huang, Zueng-Sang Chen, Soilscape of west-central Taiwan: Its pedogenesis and geomorphic implications, Geomorphology, Volume 255, 15 February 2016, Pages 81-94.
[41] James D. Stephen, Warren E. Mabee, Amadeus Pribowo, Sean Pledger, Randy Hart, Sheldon Tallio, Gary Q. Bull, Biomass for residential and commercial heating in a remote Canadian aboriginal community, Renewable Energy, Volume 86, February 2016, Pages 563-575.
[42] Maya Dawood, Cindy Cappelle, Maan E. El Najjar, Mohamad Khalil, Bachar El Hassan, Denis Pomorski, Jing Peng, Virtual 3D city model as a priori information source for vehicle localization system, Transportation Research Part C: Emerging Technologies, Volume 63, February 2016, Pages 1-22.
[43] Jacob A. Napieralski, Thomaz Carvalhaes, Urban stream deserts: Mapping a legacy of urbanization in the United States, Applied Geography, Volume 67, February 2016, Pages 129-139.
[44] Ana Elisa Pereira Silva, Corina da Costa Freitas, Luciano Vieira Dutra, Marcelo Beltrão Molento, Assessing the risk of bovine fasciolosis using linear regression analysis for the state of Rio Grande do Sul, Brazil, Veterinary Parasitology, Volume 217, 15 February 2016, Pages 7-13.
[45] Jian Huang, Emmanuel A. Frimpong, Modifying the United States National Hydrography Dataset to improve data quality for ecological models, Ecological Informatics, Volume 32, March 2016, Pages 7-11.
[46] Taylour G. Burton, Hanadi S. Rifai, Zacariah L. Hildenbrand, Doug D. Carlton Jr, Brian E. Fontenot, Kevin A. Schug, Elucidating hydraulic fracturing impacts on groundwater quality using a regional geospatial statistical modeling approach, Science of The Total Environment, Volumes 545–546, 1 March 2016, Pages 114-126.
[47] Marcus Eng Hock Ong, Win Wah, Li Yang Hsu, Yih Ying Ng, Benjamin Sieu-Hon Leong, E. Shaun Goh, Han Nee Gan, Lai Peng Tham, Rabind Antony Charles, David Chee Guan Foo, Arul Earnest, Geographic factors are associated with increased risk for out-of hospital cardiac arrests and provision of bystander cardiopulmonary resuscitation in Singapore, Resuscitation, Volume 85, Issue 9, September 2014, Pages 1153-1160.
[48] Crystal Safadi, Wind and wave modelling for the evaluation of the maritime accessibility and protection afforded by ancient harbours, Journal of Archaeological Science: Reports, Volume 5, February 2016, Pages 348-360.
[49] Jonathan P. Traylor, Vitaly A. Zlotnik, Analytical modeling of irrigation and land use effects on streamflow in semi-arid conditions, Journal of Hydrology, Volume 533, February 2016, Pages 591-602.
[50] Ivan Potić, Rajko Golić, Tatjana Joksimović, Analysis of insolation potential of Knjaževac Municipality (Serbia) using multi-criteria approach, Renewable and Sustainable Energy Reviews, Volume 56, April 2016, Pages 235-245.
[51] Karen B. Eden, Annette M. Totten, Steven Z. Kassakian, Paul N. Gorman, Marian S. McDonagh, Beth Devine, Miranda Pappas, Monica Daeges, Susan Woods, William R. Hersh, Barriers and facilitators to exchanging health information: a systematic review, International Journal of Medical Informatics, Volume 88, April 2016, Pages 44-51.
[52] Yazhen Xiao, Haisu Zhang, Timothy M. Basadur, Does information sharing always improve team decision making? An examination of the hidden profile condition in new product development, Journal of Business Research, Volume 69, Issue 2, February 2016, Pages 587-595.
[53] Zahoor Ahmed Soomro, Mahmood Hussain Shah, Javed Ahmed, Information security management needs more holistic approach: A literature review, International Journal of Information Management, Volume 36, Issue 2, April 2016, Pages 215-225.
[54] Alexandra N. Nowbar, James P. Howard, Judith A. Finegold, Perviz Asaria, Darrel P. Francis, 2014 Global geographic analysis of mortality from ischaemic heart disease by country, age and income: Statistics from World Health Organisation and United Nations, International Journal of Cardiology, Volume 174, Issue 2, 15 June 2014, Pages 293-298.
[55] Gisela Lüscher, Philippe Jeanneret, Manuel K. Schneider, Lindsay A. Turnbull, Michaela Arndorfer, Katalin Balázs, András Báldi, Debra Bailey, Karl G. Bernhardt, Jean-Philippe Choisis, Zoltán Elek, Thomas Frank, Jürgen K. Friedel, Maximilian Kainz, Anikó Kovács-Hostyánszki, Marie-Louise Oschatz, Maurizio G. Paoletti, Susanne Papaja-Hülsbergen, Jean-Pierre Sarthou, Norman Siebrecht, Sebastian Wolfrum, Felix Herzog, Responses of plants, earthworms, spiders and bees to geographic location, agricultural management and surrounding landscape in European arable fields, Agriculture, Ecosystems & Environment, Volume 186, 15 March 2014, Pages 124-134.
[56] Jennifer Whyte, Angelos Stasis, Carmel Lindkvist, Managing change in the delivery of complex projects: Configuration management, asset information and 'big data', International Journal of Project Management, Volume 34, Issue 2, February 2016, Pages 339-351.
[57] Flávio Dusse, Paulo Simões Júnior, Antonia Tamires Alves, Renato Novais, Vaninha Vieira, Manoel Mendonça, Information visualization for emergency management: A systematic mapping study, Expert Systems with Applications, Volume 45, 1 March 2016, Pages 424-437.
[58] Farzad Alamdar, Mohsen Kalantari, Abbas Rajabifard, Towards multi-agency sensor information integration for disaster management, Computers, Environment and Urban Systems, Volume 56, March 2016, Pages 68-85.
[59] Huaiyong Shao, Xiaofei Sun, Haoxue Wang, Xiaoxue Zhang, Zhiying Xiang, Rui Tan, Xuanyi Chen, Wei Xian, Jiaguo Qi, A method to the impact assessment of the returning grazing land to grassland project on regional eco-environmental vulnerability, Environmental Impact Assessment Review, Volume 56, January 2016, Pages 155-167.
[60] Jorge Alberto Rosas-Flores, Dionicio Rosas-Flores, José Luis Fernández Zayas, Potential energy saving in urban and rural households of Mexico by use of solar water heaters, using geographical information system, Renewable and Sustainable Energy Reviews, Volume 53, January 2016, Pages 243-252.
[61] Michelle M. Maresh-Fuehrer, Richard Smith, Social media mapping innovations for crisis prevention, response, and evaluation, Computers in Human Behavior, Volume 54, January 2016, Pages 620-629.
[62] F.D Tillman, S.M. Wiele, D.R. Pool, A comparison of estimates of basin-scale soil-moisture evapotranspiration and estimates of riparian groundwater evapotranspiration with implications for water budgets in the Verde Valley, Central Arizona, USA, Journal of Arid Environments, Volume 124, January 2016, Pages 278-291.
[63] Yu-Chuan Liu and Hong-Mei Gao, Chapter 12 - Development and Applications of Mobile Farming Information System for Food Traceability in Health Management, In Emerging Topics in Computer Science and Applied Computing, edited by Dhiya Al-JumeilyAbir HussainConor MallucciCarol Oliver, Morgan Kaufmann, Boston, 2016, Pages 244-268.
[64] Daniel A. Vallero, Chapter 10 - Addressing Biotechnological Pollutants, In Environmental Biotechnology (Second Edition), Academic Press, Boston, 2016, Pages 447-488.
[65] Ekbordin Winijkul, Laura Fierce, Tami C. Bond, Emissions from residential combustion considering end-uses and spatial constraints: Part I, methods and spatial distribution, Atmospheric Environment, Volume 125, Part A, January 2016, Pages 126-139.
[66] Shiori Shimokawa, Hidetoshi Fukahori, Weijun Gao, Wide-area Disaster Pre-

vention of Storm or Flood Damage and its Improvement by Using Urban Planning Information System, Procedia - Social and Behavioral Sciences, Volume 216, 6 January 2016, Pages 481-491.

[67] M.V. Eitzel, Maggi Kelly, Iryna Dronova, Yana Valachovic, Lenya Quinn-Davidson, Jon Solera, Perry de Valpine, Challenges and opportunities in synthesizing historical geospatial data using statistical models, Ecological Informatics, Volume 31, January 2016, Pages 100-111.

[68] Ariane Liu, Damien Giurco, Pierre Mukheibir, Urban water conservation through customised water and end-use information, Journal of Cleaner Production, Volume 112, Part 4, 20 January 2016, Pages 3164-3175.

[69] Marcus Eng Hock Ong, Eng Hoe Tan, Xiuyuan Yan, P. Anushia, Swee Han Lim, Benjamin Sieu-Hon Leong, Victor Yeok Kein Ong, Ling Tiah, Susan Yap, Jerry Overton, V. Anantharaman, An observational study describing the geographic-time distribution of cardiac arrests in Singapore: What is the utility of geographic information systems for planning public access defibrillation? (PADS Phase I), Resuscitation, Volume 76, Issue 3, March 2008, Pages 388-396.

[70] Jia-Gang Guo, Vounatsou Penelope, Chun-Li Cao, Utzinger Jürg, Hong-Qing Zhu, Anderegg Daniel, Rong Zhu, Zhan-Ying He, Dong Li, Fei Hu, Ming-Gang Chen, Tanner Marcel, A geographic information and remote sensing based model for prediction of Oncomelania hupensis habitats in the Poyang Lake area, China, Acta Tropica, Volume 96, Issues 2–3, November–December 2005, Pages 213-222.

[71] Richard A. Beck, Robert K. Vincent, Doyle W. Watts, Marc A. Seibert, David P. Pleva, Michael A. Cauley, Calvin T. Ramos, Theresa M. Scott, Dean W. Harter, Mary Vickerman, David Irmies, Al Tucholski, Brian Frantz, Glenn Lindamood, Isaac Lopez, Greg Follen, Thaddeus Kollar, Jay Horowitz, Robert Griffin, Raymond Gilstrap, Marjory Johnson, Kenneth Freeman, Celeste Banaag, Joseph Kosmo, Amy Ross, Kevin Groneman, Jeffrey Graham, Kim Shillcutt, Robert Hirsh, Nathan Howard, Dean B. Eppler, A space-based end-to-end prototype geographic information network for lunar and planetary exploration and emergency response (2002 and 2003 field experiments), Computer Networks, Volume 47, Issue 5, 5 April 2005, Pages 765-783.

[72] Stuart J. McLean, Hiroshi Ikegaya, Pekka J. Saukko, Huang Yung Zheng, Tomoko Akutsu, Daisuke Miyamori, Noboru Ishikawa, Koichi Sakurada, A trial of the utilization of stable isotope analysis for the estimation of the geographic origins of unidentified cadavers, Forensic Science International, Volume 232, Issues 1–3, 10 October 2013, Pages 237.e1-237.e5.

[73] Francesco Montinaro, Ilaria Boschi, Federica Trombetta, Sara Merigioli, Paolo Anagnostou, Cinzia Battaggia, Marco Capocasa, Federica Crivellaro, Giovanni Destro Bisol, Valentina Coia, Using forensic microsatellites to decipher the genetic structure of linguistic and geographic isolates: A survey in the eastern Italian Alps, Forensic Science International: Genetics, Volume 6, Issue 6, December 2012, Pages 827-833.

[74] Alexandre Sorokine, Bob G. Schlicher, Richard C. Ward, Michael C. Wright, Kara L. Kruse, Budhendra Bhaduri, Alexander Slepoy, An interactive ontology-driven information system for simulating background radiation and generating scenarios for testing special nuclear materials detection algorithms, Engineering Applications of Artificial Intelligence, Volume 43, August 2015, Pages 157-165.

[75] George Howard, Mary Cushman, Ronald J. Prineas, Virginia J. Howard, Claudia S. Moy, Lisa M. Sullivan, Ralph B. D'Agostino Sr., Leslie A. McClure, LeaVonne Pulley, Monika M. Safford, Advancing the hypothesis that geographic variations in risk factors contribute relatively little to observed geographic variations in heart disease and stroke mortality, Preventive Medicine, Volume 49, Issues 2–3, August–September 2009, Pages 129-132.

[76] Emily B. Levitan, Olusola Top Olubowale, Christopher M. Gamboa, J. David Rhodes, Todd M. Brown, Paul Muntner, Luqin Deng, Monika M. Safford, Characteristics and prognosis of acute myocardial infarction by discharge diagnosis: the Reasons for Geographic and Racial Differences in Stroke study, Annals of Epidemiology, Volume 25, Issue 7, July 2015, Pages 499-504.e1.

[77] Milena P. Chaguri, Ana Luísa Maulvault, Maria Leonor Nunes, Debora Aparecida Santiago, Juliana Célia Denadai, Fabiola Helena Fogaça, Léa Silvia Sant'Ana, Carlos Ducatti, Narcisa Bandarra, Maria Luisa Carvalho, António Marques, Different tools to trace geographic origin and seasonality of croaker (Micropogonias furnieri), LWT - Food Science and Technology, Volume 61, Issue 1, April 2015, Pages 194-200.

[78] Wesley T. O'Neal, Rikki M. Tanner, Jimmy T. Efird, Usman Baber, Alvaro Alonso, Virginia J. Howard, George Howard, Paul Muntner, Elsayed Z. Soliman, Atrial fibrillation and incident end-stage renal disease: The REasons for Geographic And Racial Differences in Stroke (REGARDS) study, International Journal of Cardiology, Volume 185, 15 April 2015, Pages 219-223.

[79] Juan J. Calvete, Libia Sanz, Alicia Pérez, Adolfo Borges, Alba M. Vargas, Bruno Lomonte, Yamileth Angulo, José María Gutiérrez, Hipócrates M. Chalkidis, Rosa H.V. Mourão, M. Fatima D. Furtado, Ana M. Moura-Da-Silva, Snake population venomics and antivenomics of Bothrops atrox: Paedomorphism along its transamazonian dispersal and implications of geographic venom variability on snakebite management, Journal of Proteomics, Volume 74, Issue 4, 1 April 2011, Pages 510-527.

[80] Roberta Jeane B. Jorge, Helena S.A. Monteiro, Larissa Gonçalves-Machado, Míriam C. Guarnieri, Rafael M. Ximenes, Diva M. Borges-Nojosa, Karla P. de O. Luna, Russolina B. Zingali, Carlos Corrêa-Netto, José María Gutiérrez, Libia Sanz, Juan J. Calvete, Davinia Pla, Venomics and antivenomics of Bothrops erythromelas from five geographic populations within the Caatinga ecoregion of northeastern Brazil, Journal of Proteomics, Volume 114, 30 January 2015, Pages 93-114.

[81] Michael L. Cheng, Li Zhang, Margaret Borok, Eric Chokunonga, Charles Dzamamala, Anne Korir, Henry R. Wabinga, Robert A. Hiatt, D. Max Parkin, Katherine Van Loon, The incidence of oesophageal cancer in Eastern Africa: Identification of a new geographic hot spot?, Cancer Epidemiology, Volume 39, Issue 2, April 2015, Pages 143-149.

[82] Agustina Perez-Llaneza, Marina Caballero, Eugenia Baravalle, Maria Mesplet, Juan Mosqueda, Carlos E. Suarez, Ignacio Echaide, Frank Katzer, Gabriela M. Pacheco, Monica Florin-Christensen, Leonhard Schnittger, Development of a tandem repeat-based multilocus typing system distinguishing Babesia bovis geographic isolates, Veterinary Parasitology, Volume 167, Issues 2–4, 10 February 2010, Pages 196-204.

[83] Nancy A. Otieno, Bryan O. Nyawanda, Allan Audi, Gideon Emukule, Emmaculate Lebo, Godfrey Bigogo, Rachel Ochola, Phillip Muthoka, Marc-Alain Widdowson, David K. Shay, Deron C. Burton, Robert F. Breiman, Mark A. Katz, Joshua A. Mott, Demographic, socio-economic and geographic determinants of seasonal influenza vaccine uptake in rural western Kenya, 2011, Vaccine, Volume 32, Issue 49, 20 November 2014, Pages 6699-6704.

[84] Vitelbina Núñez, Pedro Cid, Libia Sanz, Pilar De La Torre, Yamileth Angulo, Bruno Lomonte, José María Gutiérrez, Juan J. Calvete, Snake venomics and antivenomics of Bothrops atrox venoms from Colombia and the Amazon regions of Brazil, Perú and Ecuador suggest the occurrence of geographic variation of venom phenotype by a trend towards paedomorphism, Journal of Proteomics, Volume 73, Issue 1, 2 November 2009, Pages 57-78.

[85] Stephanie B. Wheeler, Tzy-Mey Kuo, Ravi K. Goyal, Anne-Marie Meyer, Kristen Hassmiller Lich, Emily M. Gillen, Seth Tyree, Carmen L. Lewis, Trisha M. Crutchfield, Christa E. Martens, Florence Tangka, Lisa C. Richardson, Michael P. Pignone, Regional variation in colorectal cancer testing and geographic availability of care in a publicly insured population, Health & Place, Volume 29, September 2014, Pages 114-123.