Remote sensing and evaluation of natural resources in Iran

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Abstract: Remote sensing technology using satellite access has been increasingly helpful in performing natural resources mapping and management. This includes processes that cannot be done manually or might take many years to complete when you are covering vast areas of land such as satellite imaging, accuracy assessment, image processing, classification, and geometric or radiometric corrections. It is evident that any nation's economic development is largely supported by the richness of its water and land resources. The management capability and mapping tools use to monitor these resources are crucial to raise the economic development of specific regions. Accuracy is a general requirement in managing delicate land and water resources for sustainable development. The remote sensing using satellite based approach in generating data ensures updated cost effective natural resources monitoring and management in Iran. This research will demonstrate the need to maintain remote sensing for mapping and managing natural resources in Iran as well as enhancing and supporting the decision making capabilities of the government regarding the use of its natural resources.

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1. Introduction

Remote sensing applications are the best approach in carrying effective sustainable management and evaluation of natural resources in Iran. Informing and supporting top government people about their natural resource management decisions requires precise, straight forward, accurate, current evaluation and information of the condition of Iran's land and water natural resources (Brewer, 2007). Although better information may not automatically mean being able to make better decision, limited access and limited information on the other hand, may limit decision space and quality of results. Forest management strategies need accurate, current, and comprehensive data for evaluation of its condition and developing practical sustainable solution that could address major issues in appropriate scales.

The ecosystem is always in a state of temporal and spatial scales of change mostly brought by its ever changing environment and socio-economic factors. This implies that better use of natural resources, implementation of policy, and management of natural resources especially forestry, agriculture, and freshwater farming shall be given higher importance. Surveys for natural resources directly impact the economic planning of Iran. This is especially true if the local government is keen on measuring and evaluating the annual freshwater withdrawals such as evaporation loses and finding alternative renewable resources. Recent accurate data are required to support and develop strategic planning and management decisions.

There is a need to maintain remote sensing equipments and other computer assisted satellite supported digital remote sensing data collection and processing for accurate data analysis, strategic decision making, and fast updated extraction as well as collection of information concerning natural resources. This covers land use, soil, geology, topography, vegetation, and many other related large tasks that could not be possibly completed and updated without remote sensing. The innovative, accurate, convenient, and fast collection of data is a powerful logical approach for effective and systematic management of natural resources. Suitable image processing and enhancements would facilitate interpretation of collected information.

Better use of natural resources may increase food production and help in proper utilization of natural resources to provide better living standards for the people in Iran. Inaccurate data could lead to improper use and exploitation of natural resources. This may result to disastrous management, planning, and decision making. The remote sensing technique using the satellite or plane for geophysical survey has brought new hope and approaches in supporting structural geomorphologic interpretations. Spatial

data are important for sustainable natural resources management, evaluation, and development. Mapping out the natural resources to monitor the environment is attainable by using satellite images, aerial photos, and accurate information on land topographic maps. Accurate and fast evaluation of ecological studies for decision making can facilitate economic growth and reveal the potential of the specific region of study.

Remote sensing is the best model for monitoring the environmental conditions in Iran where the most recent technology in resource identification are being used for accuracy in topographic maps interpretation. Satellite images and aerial photographs produce clearer spatial information, which makes rebuilding and correcting natural resources planning and management easier. In today's world, where human activities include utilization of natural resources, it is crucial to take measures and avoid ecological destruction initiate renovation of resources, and increase awareness about overall conservation of environment. The aim of this research is to provide reasonable methods that could help preserve and enhance the potentials of Iran's natural resources. Inattentive use combined with unwise application of images and photographs could lead to disastrous planning over limited and vulnerable resource.

2. Theoretical basis of the research:

Regarding the above-mentioned cases as well as various spatial, environmental, social and economical conditions, the historical breadth, growth rate, and the development of the countries, there have been raised some different theories and viewpoints concerned the rural well being that the most important of them are referred here; from a morphological and philosophical viewpoint, of course, rural well being is as important as justice, equality, freedom, and citizen rights , that in some cases, they are considered as the complements of it and sometimes they are regarded as the bases for it or even as an aim or a tool for achieving it. From an economical point of view, as we know, the western countries economy has been influenced by the classical schools of thought derived from some thinkers ' theories such as Adam Smith, David Ricardo, and Malthus, during two hundreds years ago. In this kind of the schools, the social rural welfare, in a wide sense, is influenced by the individual values and satisfaction.

The framework of sustainable natural resources management involves maintaining the balance of the country's social demands, economic needs, and ecosystem requirements (Kharazipour, 2009). Evaluating the three factors would help government leaders and economist accurately match policy against economic and social demands with a list of scientific focus. Remote sensing applications technically strengthened the local as well as international competitiveness of Iran with its satellite and aerial systems imaging capabilities. The technology provides useful applications for system advancement, change management, and natural resources policy besides the collection, processing, and archiving of satellite images. This could substantially shape the economic success of Iran. The risk of the application lies on the skill and knowledge of the operator of the remote sensing equipment about on-orbit coordinates and launch timings. The expense involved in the program cost and schedule is relatively huge. One big risk is cost containment. Iran needs to train people and pursue exchange of knowledge to successfully operate a full satellite imaging system into the orbit.

Technical expertise is a prerequisite for accuracy and cost containment. There is a need to provide information that could be used in making management decisions and shaping the choices for policy, licensing, competitiveness, and national security in a rapidly changing climate and global marketplace. Nurturing technology to better support government derivatives for resource management and national security requires substantial financial funding and openness to foreign systems. Resource management is best managed by remote sensing capabilities regardless if the goal is commercialization or traditional government programs. Remote sensing and image interpretation provide digitally based systems and accurate analysis techniques to obtaining information using electromagnetic radiation in direct contact with the large area for evaluation.

Remote sensing has occupied a very important role acquiring information about land cover, vegetation, seabed topography, and water quality (Jong & Meer, 2006). Remote sensing has also taken significant role in the disciplines of agriculture, oceanography, geology, forestry, geography, meteorology, civil engineering, and zoology. The ecological system of Iran needs consistent monitoring, management, and evaluation for accurate gathering of data about various environment processes that could help determine and increase the understanding of the users. Measuring and evaluating the differences of the past and present conditions of the natural resources help define the complex dynamics of the ocean circulation as well as the complex pattern of detecting water and nutrient deficits (Jong & Meer, 2006). The application provides accurate changes in the advancing and withdrawing of the desert sand and collects information necessary to monitor and maintain Iran's forest or nature reserves. This is also important in

classifying and recognizing types of vegetation, determining disease of vegetation, and identifying stressed or damaged vegetation.

Techniques such as the GPS or global positioning system, GIS or geographic information systems, environmental monitoring, SFAI or small format aerial imagery, and mapping require skills and knowledge about remote sensing, landsat, and optical mechanical scanning systems. The techniques are necessary to perform thematic mapping and inventory of natural resources. Aerial photography could potentially reduce cost by at least 35% in performing mapping, planning, and inventory (Paine & Kiser, 2003). Approaches to interpretation are necessary to extract information using visual inspection of digital images and computerized quantitative analysis.

3. Material and Methods

This study uses statistical analysis, literature review, and field observations. The features and topographic characteristics of the desert in Iran reflect the region's severe thermal climatic situation. The knowledge about any surface type diurnal temperature patterns, trend of surfaces, calculation of correlations between surface types and climatic elements, and behavioural pattern during any hour of the day of the natural resources in Iran provide researchers and top government officials the most accurate data that would lead them to develop thermal characteristics models, evaluate natural resources, and predict behaviour in terms of economic relevance. Iran's natural resources biological systems, temperature and behavioural patterns, and physical systems are important in maintaining and interpreting the relationship of man's economic activities to the ecosystem. Thermal remote sensing application has been increasingly making people aware of its role in the country's economy. Remote sensing images facilitate environmental impact prediction. Time series satellite imageries studies were reviewed to evaluate how the application helps regional natural vegetation development.

Qualitative prediction models are important in identifying suitable sites for possible groundwater artificial recharge. Remote sensing helps carry out the task for environmental inventory and valuable information for vegetation cover, topography, and habitat destruction. Quantifying regional habitat could be difficult without the appropriate tools and applications. This study will gather important data to prove that remote sensing is better and more cost effective than traditional data collection method. Intensive literature and related researches about Iran's drought, desertification, soil brining, surface water reduction, desert area expanding, pasture ruination, and underwater surface loss were performed to identify the role of remote sensing in maintaining and improving the ecosystem in Iran.

4. Results and Conclusions

A satellite aerial photograph taken from an altitude of 250 km can cover an area of 190 km x 130 km. A false colour infrared aerial photograph taken from an altitude of 760 m can cover an area of 1.1 sq. km. A thermal infrared image taken from an altitude of 620 km can cover 70 km x 100 km. The infrared image comes out with colour coding such as blue for lowest and red for highest radiation emission. Data may be taken using three band colour composite passive microwave to monitor sea-ice concentrations on specific regions using vertical polarisation. Vegetation index and other important topographic images could be analyzed using the remote sensing technique. Remote sensing allows researchers to collect information using images and electromagnetic radiation, ultraviolet or radio frequencies, without the need for physical contact. However, the enormous opportunity offered by the remote sensing applications has been heavily pulled down by the cost of acquiring the data.

GIS raw data could be transformed into useful information such as forest and renewable resources inventories, mapping, and assessment of urban growth. The sales of GIS raw data, including hardware and software, amount to $2 billion per year (Williamson, 1993). Only the GIS hardware and software has the capability to carry and perform spatial data from several formats to usable computer files. The Land sat satellites and its systems cost about $320 million. Land sat 7 cost from $440 to $640 million (Williamson, 1993).

The best way to evaluate the value of remote sensing is to identify the opportunities that it offers. One of the tangible advantages in using the application is its ability to obtain data from vast area of land surface or large volume of the atmosphere in a very short period of time using instantaneous snapshots (Rees, 2001). The other tangible advantage is the fact that the application generates digital information that is calibrated and ready for feeding into the computer for further analysis without long conversions and other processes. The power of remote sensing includes measuring environmental variables such as wind velocities, gas concentrations, ozone, temperature, and clouds (Rees, 2001). Remote sensing can measure land surfaces topography, soil moisture content, land cover type, reflectance, temperature, and tectonic motion. Ocean and water surfaces such as ocean tides, temperature, current, and topography could be measured and taken

accurately using remote sensing. The snow, glaciers, icebergs, and ice sheets condition, behaviour, and distribution could be monitored using the application. Remote sensing could be applied to a large number of opportunities and disciplines especially pollution monitoring, land and water resource mapping, and soil characterization. Most spaceborne observations are possible only using the remote sensing applications.

The cost involve in maintaining remote sensing often relate to the idea of achieving and balancing potential gains. The user needs to create proper mission planning with full consideration of the total cost that goes with data collection and processing. The remote sensing application detects radiation and active naturally occurring systems for analysis (Rees, 2001). Iran needs to develop a conceptual design of low orbiting satellite with remarkably low cost and weight that may accommodate an easy to remove mounting panels located at the interior as well as a removable hull. This low cost low orbiting satellite is smaller and allows Iran to place more satellites into the space with shorter turn around times. This reduces production cost on developing large expensive satellites. The LOFTS or Low Orbiting Fourier Transform Spectrometer Satellite design could cost less than $3 million. Each additional reproduction of the original copy would give at least 25% to 50% savings on cost (Miau & Holdaway, 2000). The LOFTSS design is to carry the FTS or Fourier Transform Spectrometer. The FTS is an instrumentation package used for remote sensing application that weighs only 8 kg. FTS can absorb infrared and visible regions. It can also operate in emission mode even within an infrared region and perform a variety of applications related to remote sensing in terms of climate change, meteorology, atmosphere, and planetary exploration.

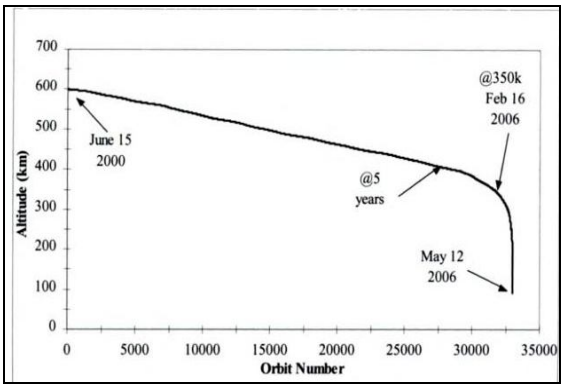

Figure 1. Lifetime analysis of LOFTSS ((Miau & Holdaway, 2000))

The LOFTSS yields a lifetime of 5.9 years bearing an altitude of 600 km (Miau & Holdaway, 2000). The altitude should be lowered to 405 km after 5 years which is still above the minimum required altitude of 350 km. Orbit decay rate is 1.5 km per day from an altitude of 407 km. Composites use would cost at least $1,000 for the propulsion system, which is about 3% of the total costs.

The cost breakdown of the LOFTSS is cheaper than producing large satellite. The LOFTSS design meets most of the goals for remote sensing the natural resources in Iran. The likelihood of failure is only 4.2% (Miau & Holdaway, 2000). Most of the operations involving space borne remote sensing are national or international programs (Rees, 2001). Their costs are not made public for security reasons.

Risk Factor	1994 Perceived Risk	2001 Perceived Risk (relative to 1994)
Technical	Low	Higher
Market	Low	Higher
Policy & Regulatory	Medium	Lower
Foreign Competition	Medium	Higher

Figure 2: Perceived risks of using commercial satellites in 1994 compared to 2001

Failures may be attributed to users' lack of knowledge, technical expertise, resources, and management skill that can place fully operational remote sensing satellite into the orbit (O'Connell, 2001). This technology may adopt new business models to come up with new information formats they can use for management decisions and collection of imagery data. There were evidences indicating large scale remote sensing systems were not generating enough revenues from their collection of raw data to even cover the cost of building and operating the satellites. In 1990, constructing and launching two Landsat satellites ranged from $0.75 billion to $1 billion (The Congress of the United States Congressional Budget Office, 1993). The amount came up to an annual cost of about $85 million to $110 million in terms of cost of capital, insurance, and maintenance.

6. Discussion

The cost of building large satellites could cripple the budget of Iran only if they cannot find market for the raw data they collected using remote sensing. Even though it has its own local use for predicting natural hazards and evaluating the condition of Iran's

natural resources, it is important that the government could translate some images into commercial market value to cover cost. Reducing the impact of natural disasters is possible with the use of remote sensing applications. Sandstorm or landslide inventories could be made by performing susceptibility mapping that would lead to identification of hazard zones. Setting up a remote sensing application and satellite system for Iran actually means also considering market distribution and commercial value of collected raw data. To be able to continuously operate the facility, Iran should choose the low cost LOFTSS satellite and hire a marketing planning consultant for the raw data translation to commercial value.

It is important to derive revenues from its application in order to cover operational cost. There could be improved methods in segregating top secret profiles and raw data from commercial raw data. The marketing aspect should be presented along with the cost of building the remote sensing satellite to be able to evaluate how much cost should the government handle each year. However, improved market prospects largely depends on the speed, capability, and processing of the remote sensing satellite system. Continued development of the GIS software and hardware is one major consideration to make it possible for the raw data available to a wider audience. Planning on how to market the raw data should support the mission of the remote sensing satellite.

The problem with the remote sensing application besides skills and knowledge is actually the market value conversion of the raw data. This happens to be more important in evaluating the feasibility of the project. Enhanced data and translation of its commercial value will greatly contribute to the maintenance and operational costs of the remote sensing satellite system. Choosing the LOFTSS is more feasible and attainable than the large satellites. This could generate Iran profits if the marketing aspect is handled well. The coordination between marketing and government operations will enhance and direct the flow of the project. The lack of clarity and segregation of the categories and use of raw data may impede market transformation of the information. Market growth could reduce operational cost. This means finding more market for the raw data, segregating the raw data, and determining pricing policies as well as alternative low cost aerial imaging. This idea will enable Iran to solve financing and technical problems. The systems could be improved if there is a defined market. Commercialization may not be a good idea but it helps carry the burden of the cost of building and operating remote sensing. If Iran can gain profits from transformation of raw data to commercial data, then the focused now would be the process of segregating top secret data from commercial data.

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