

The Modeling of Natural and Socioeconomic Factors of Desertification and its Particularity for The Republic of Armenia

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Abstract

The Republic of Armenia, located in the dry land sector of a subtropical climate zone, carries a great risk of desertification. This is due to an existing arid climate marked by sporadic mountainous terrain, scarce vegetation, frequently recurring droughts, devastatingly heavy precipitation, all combined with millennia of human utilization of the ecosystem.

Desertification processes exhibit similar patterns in many arid countries of the world, where differences exist only in local natural and socio-economic factors.

While modeling desertification, it is important to distinguish not only global scale factors but also regional and local influences. The application of modeling methodology to the research of natural, socio-economic and other phenomena allows the differentiation of factors based upon their characteristics of origin, rates of influence, causal relationships and other indicators. While developing mechanisms to prevent or mitigate the negative effects of these factors, model schemes help to choose dominant factors correctly, to apply a mathematical apparatus for carrying out systematic analysis, etc.

In this work, an attempt was made for the first time to model elements of natural and socio-economic factors of desertification by showing their reciprocal relationships and influence on occurrences of desertification.

Desertification research can only be effective if it exhibits comprehensive studies of the landscape. This would allow for the identification of the main phenomenon causes, quantitative assessment of physical, biological and social processes, development of a forecast mechanism, and outlining of procedures to lessen desertification and possibilities for adaptation.

Keywords: desertification, model, arid lands, degradation

Introduction

One of the major theses of Geographic studies of the last decade is the disclosure of casual connection of global changes occurring. Among the latter the global climate change, biodiversity loss, land degradation, desertification and other issues are especially important. In this respect, dryland ecosystems of the Earth are especially vulnerable since the negative human impacts are felt quicker.

UNO's "Convention to Combat Desertification" defines this phenomenon as land degradation in arid, semi-arid and dry sub-humid areas resulting from climatic variations and human activities (UNCCD 1997). We believe desertification phenomenon in mountainous conditions acquires special resonance in its landscape perception including the degradation of not only land or any other natural component, but the degradation of the whole landscape (ecosystem) under the influence of natural and anthropogenic factors.

Calculations show, that the areas affected by anthropogenic desertification occupy 10mln km² of the Earth or 6.7% of the terrestrial land. This process continues with accelerating trends reaching 15 million hectares annually, including 3.2 million hectares pastures and 2.5 million hectares arable land.

Realizing, that the climate change has gained global scales and threatens many countries of the world, and that the combat against the phenomenon can be organized only in a coordinated way and with common efforts the international community launched the combat against the desertification developing the main strategic directions and implementation mechanisms of that combat that were expressed in the UNO's "Convention to Combat Desertification". This convention includes an important qualitatively new baseline principle which is related to the prioritization of the involvement of the local population in the combat against desertification. This is the whole philosophy underlying the organization of the combat (convention). A great importance is placed over the fields of science, technology and creation of own potential in the convention.

Being situated in the arid continental sector of the subtropical climatic zone the Republic of Armenia is under a serious desertification risk. This risk is related to the fact that here the arid climate is combined with severe fragmentation of the relief, poor vegetation cover, as well as frequently repeating draughts, destructive downpours and in addition the millennia history of nature use by the human society.

Today, 80% of the total territory of the Republic of Armenia is subject to different degree of desertification, moreover severely desiccated areas constitute 26.6% of the total territory of the Republic of Armenia.

Thus, comprehensive study of the desertification phenomenon, the global and local issues of the development of mitigation and adaptation technologies have become an issue of serious attention for many governments of the world, including the Republic of Armenia.

Modernity of the issue is connected to the fact that in the RA arid mountainous natural climatic conditions, as well as on the background of unstable socio-economic situation the visible global climate change activates the desertification phenomena in the RA territory.

Hence, the results of the studies must serve as basis for carrying out measures against desertification, as well as for the development of new socio-economic strategy of nature use.

During the study of natural, socio-economic and a number of other multi-factorial phenomena the application of modeling method enables the differentiation of the factor according to their genetic characteristics, sizes of influence, casual connection and other indicators. While developing mechanisms for the prevention or mitigation of negative impacts of these factors model schemes assist in the correct selection of dominants, applying mathematical apparatus for carrying out a system-oriented analysis and etc.

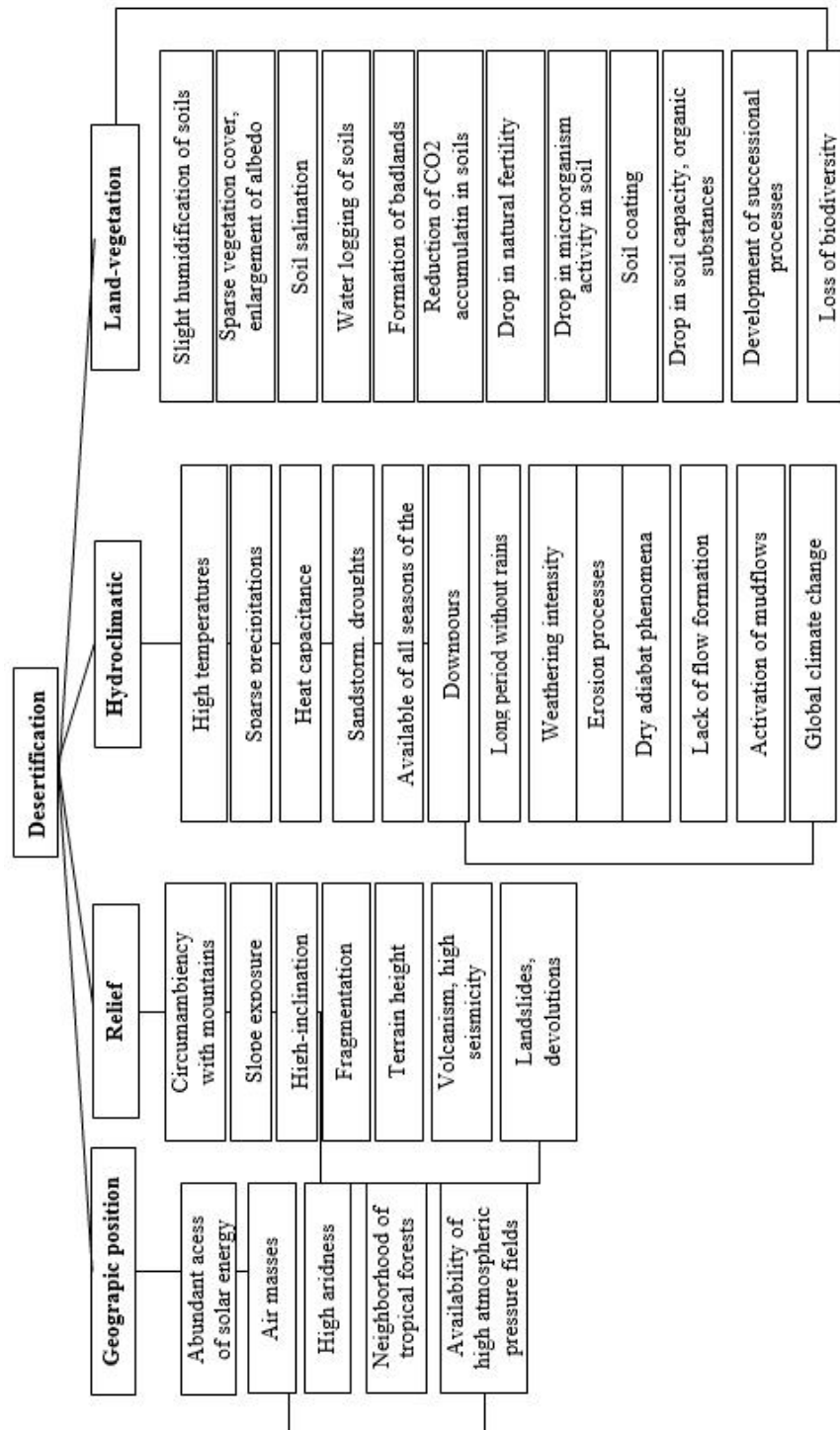
Modeling helps to integrate combined effect of phenomena.

Our work is the first attempt to model the desertification of the components of natural and socio-economic blocks, showing their correlation and the formation of complexes of desertification phenomenon.

The components of natural and anthropogenic blocks are divided into numerous groups and subgroups. The fundamentals of the components of the natural block are geographic location of the country under study, geographic latitude and position in the continent (marginal or central part of the land), the characteristics of the bedrock, relief features and etc.

The model of natural factors clearly demonstrates that the geographic location of the Republic of Armenia, quantity of solar energy accessing, the characteristics of the general circulation of the atmosphere, undulation are the functioning against the primary factors of desertification, and many other components are to some extent derivatives which may appear mainly as regional factors (Picture 1).

Picture 1: Model of natural factors of desertification in RA



The impact on the desertification process of the mentioned factors highlighted in the model can be expressed directly or indirectly. But if we judge by "cause-effect" or "impact-change" principle, then we can assuredly say, that the quantity, seasoning and the possibility of flow formation of atmospheric precipitations are the "number one" criteria of the desertification.

Being situated between 38-42° north-eastern parallels, the RA territory occupies the northern part of the subtropical zone. If the terrain was plain we would indeed have typical subtropical natural landscapes everywhere (as Kura Arax plain). But being situated far away from seas, landlocked with mountain chains, having high altitude above sea level and carrying the effect of adjacent southern large arid areas only a very small portion of lowlands of the republic have natural complexes peculiar to subtropics (moreover to arid subtropics). Here the radiation balance, seasonal and daily temperature fluctuations are significant, whereas the quantity of precipitations is scarce and the vegetation period is mostly arid.

Water balance in the most part of the area is negative (heat capacitance prevails the quantity of precipitation) and there is no stable flow formation, erosion processes of slopes are intensifying due to their southern exposition and steepness as well as because of frequent downpours and etc. All mentioned factors are reflected in the scheme of the model without highlighting complex reciprocal connections. Since these factors have different degree of influence and different correlation to other factors in different regions of the Republic of Armenia therefore, the classification based on the cause-effect principle is extremely difficult.

In the block of socio-economic factors of desertification in the RA conditions violations in the agricultural sector are predominating. Here, any deviation from the rules of land use, directly or indirectly supports desertification. In the mountainous, arid climate conditions, land processes exceed indicators of plain and humid regions multiple times. In this respect, serious stimulators of desertification are hill ploughing, violations of irrigation rules, frequent access of mechanisms into the fields, overgrazing of pastures, the absence of crop rotation and other violations of land use technology, which on one hand accelerate the erosion process and on the other hand impoverish the vegetation cover (Picture 2).

During the course of years, in the field of industry toxic and active gases from factories, wastewaters, the dust of concrete as well as waste and dust emissions from mines contribute to the process of desertification. In this case, because of the accumulation of chemical active substances, dust and other ingredients in the vicinity of the mentioned objects soil loses its applicability, the vegetation cover destroys or becomes extremely sparse and the natural environment in the vicinity of nuclear power plants becomes a dangerous radioactive zone after its closure at least a few decades later.

In the RA mountainous conditions construction and transport play a significant role in the desertification process. Due to non-prudent land allocations for construction purposes land parcels rich in humus are being alienated, large areas are being occupied by construction wastes, greenhouse gases and sulfuric gases that cause acid precipitations are being emitted into the air basin by the internal combustion engines. The effect of the country's political and social situation plays a significant role in the desertification process.

Severance (or weakening) of the RA's economic relations with the former Soviet Union republics, military operations, the blockade of the republic created serious preconditions for the energy crisis, deforestation intensification, land desertification, unemployment, migration, poverty, abandonment of settlements by the population.

These negative phenomena aggravated the situation resulting in wrong land privatization, imperfections in the legislative and administrative fields, unsatisfactory funding, as well as lack of markets, technical satiety and low environmental awareness of the population and other reasons.

The diversity of natural prerequisites of desertification in the RA is first of all conditioned by geographical position. We have already mentioned that the RA territory is situated between the borderlines of the subtropical and temperate zones, where the influence of air masses moving from the dry deserts of the Middle East are predominating during the year. As a result a very dry climate regime is created in the mountainous conditions, which is extremely favorable for the development of desertification phenomenon.

Thus, the geographic location, undulation, arid nature of the climate and vegetation cover are among the predominating natural conditions contributing to the desertification in the RA. Each of which is expressed in different way and with different strength in different regions.

If we classify the natural factors of desertification by origin, then the geographic position (geographic latitude) is followed by solar energy balance, followed by the movement of air masses, arid continental nature of the climate, proximity of desert regions, priority of atmospheric high pressure fields especially in the warm period of the year.

Mountainous conditions are no less important preconditions for desertification, especially the height above sea level, slope exposure, degree of inclination, rock origin, water permeability, existence of landslides and seismic danger.

Climatic preconditions of desertification in the RA conditions are extremely numerous and diverse and high temperatures, significant fluctuations of annual and daily temperatures, scarce precipitations, long rainless periods, high heat capacitance, prevalence of downpours and other factors are predominating among them.

An entire group of natural factors of desertification is related to the nature of soil and vegetative cover. Most of them are acting as consequences of socio-economic activities, whereas others are the result of the impact of the natural factors. Overgrazing of pastures, non correct ploughing of fields, irrigation regime and others belong to the first group, whereas high long-term air temperatures, low relative humidity, droughts, sandstorms and others belong to the second group.

Thus, both natural and socio-economic factors of desertification act in reciprocal relations, numerous combinations and cause-consequential complexes.

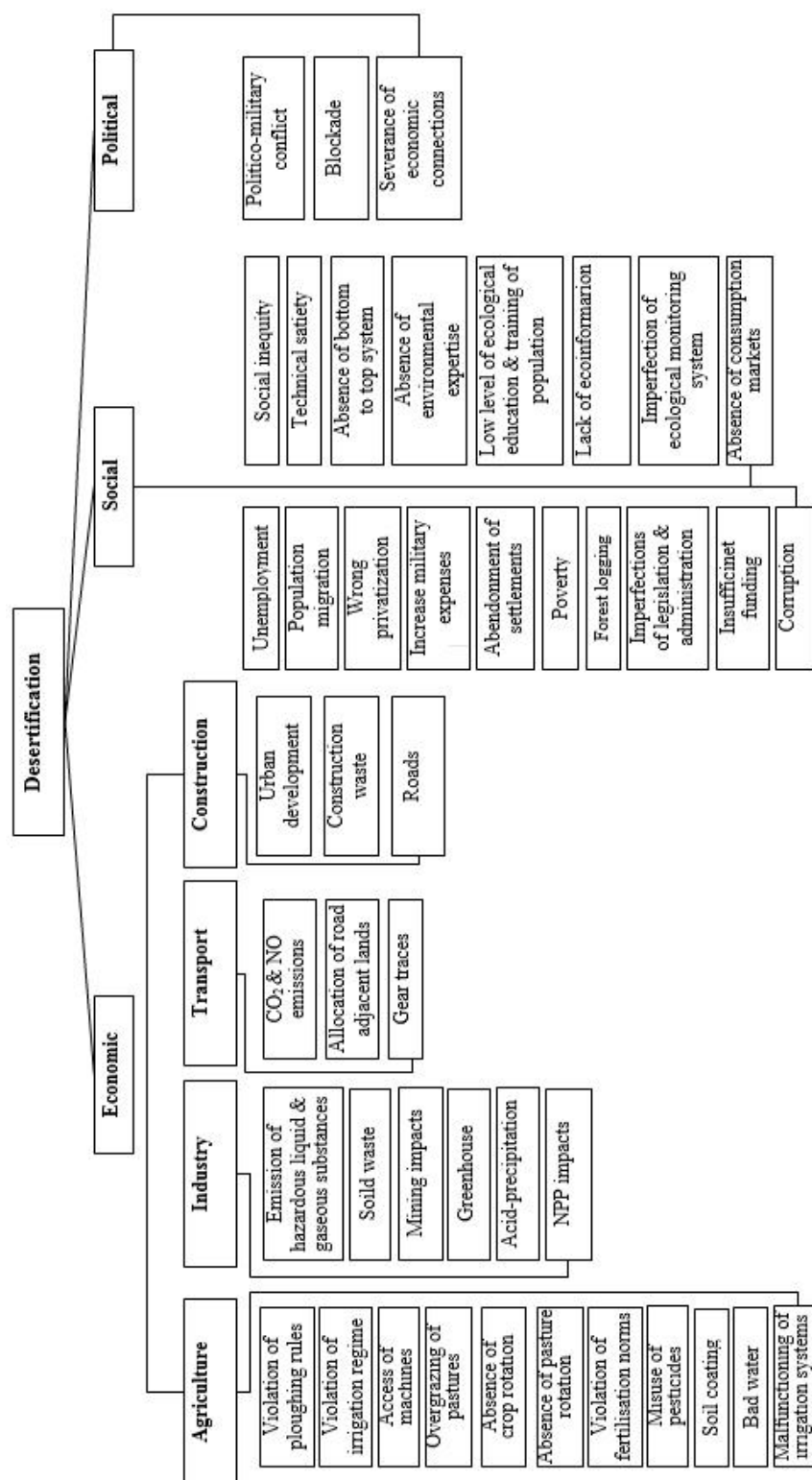
While discussing the issue of desertification not only the abovementioned factors are taken into account, but also numerous other natural and anthropogenic factors, which obtain significant importance in the development of technologies to combat desertification on local scale. However, during the analysis on the republican scale, we consider it appropriate to be guided by Ashby's principle according to which factors having insignificant role are ignored from the complex of factors, that is, the principle of limitation of wide range of information is used, which is also known as "Occam's razor" principle, which states: "It is not worth doing something by means of a greater one, if it can be achieved by the help of a small one."

This thesis is especially advisable for the application in the mountainous conditions where the number of factors is greater multiple times as compared to the plains. In the present case, it is necessary to define a limited number of dominant factors describing the phenomenon on a correct level through deep analysis of several dozens of both natural and socio-economic factors of desertification.

This principle is particularly advantageous for one simple reason that we still do not have objective information on monitoring of natural and socio-economic factors of different sectors. In such circumstances, approximate accuracy of factors, the use of unreliable, unchecked materials result in a greater distortion of the situation assessment.

An important conclusion emanates from here, that is, the selection of descriptive factors should be made through detailed analysis based on physical, biological, geographical, socio-economic and other grounds and through establishing (discovering) reliable correlations of these grounds with desertification processes.

Picture 2: Model of socio-economic and political factors of desertification in RA



Based on the abovementioned, complete desertification (multifactorial) model on the RA territory today cannot claim a right of a mathematically justified model. But its abbreviated version, which is built on the system of predominating factors, has a sound physicochemical, biological, geographical, socio-economic and other objective arguments, which may serve as a sufficient basis for assessing the real state of the desertification process.

It is evident, that in the mountainous conditions of the Republic of Armenia the assessment of the desertification phenomenon and the development of measures for combating it should be made taking into account the specific conditions of each region.

The components given in the model can serve as a guide in giving priority to this or that social and natural desertification factors, as well related to the main factor in organizing combat against other factors.

The modeling scheme will assist in organizing the strategy of combating desertification in a professionally correct way, taking into consideration the levels of legislative and administrative systems, ecologisation programs of the economy and the role of science and education in the public awareness raising and organizing the combat against desertification.

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