REVERSE ENGINEERING GEOMORPHOLOGIC (REG) IMPLEMENTATION FOR THE REGION GEOMORPHOLOGIC ANALYSIS

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Abstract: This technique (Reverse Engineering) is used in most fields and equipment reconstruction, but in the field of geomorphology has not found a place that in this paper, the new idea of using this method is shown in geomorphology based on REG concept, it can be said that geomorphology unknowns consisted of the three vectors of displacement, velocity and time. It can be conclude that the geomorphological reverse engineering that is the idea of using reverse engineering in geomorphology and is presented here.

Keywords: Reverse Engineering, geomorphological reverse, Implementation for the Region,REG

1. Introduction

Reverse engineering, is the processes of extracting knowledge or design information from anything man-made and re-producing it or re-producing anything based on the extracted information (Eilam, 2005). Geomorphology can be defined as follows:

Geomorphology as a discipline in Earth Science has its roots from Geology, Hydraulic Engineering and Physics. This is different from other natural sciences in that its focus is on the study of the processes of production, movement and storage of sediment within the landscape and on the characterization of the features these processes produce. In its widest definition, Geomorphology encompasses the study of glacial, coastal, slope, wind and fluvial processes of sediment movement across the surface of the Earth (Sear et al. 2003).

And in other definition, the Geomorphology is therefore a discourse on Earth forms. It is the study of Earth. It is the study of Earth's physical land surface features, its landforms-rivers, hills, plains, beaches, sand dunes, submarine landforms, landforms of other terrestrial and myriad others (Huggett, 2007)

So, according to these definitions of reverse engineering and geomorphology, it can be said that the geomorphological reverse engineering that is the idea of using reverse engineering in geomorphology and is designed by the authors, is defined as follows:

This method (REG) is based on the size and direction of processes and physical forces and geometry of geomorphological landforms during time that modeled landforms changes on the basis of four parameters (x, y, z, t). Components of coordinates (x, y, z) obtained through mapping techniques, descriptive characteristics through sedimentology, geology, hydrology, and time (t) component through dating methods. So REG model is information extraction from the geomorphological landforms and geometry simulation in the present and past and then re-creation of the landforms geometry in the coming times. REG conceptual model shown in the figure below, followed by the options of the model.

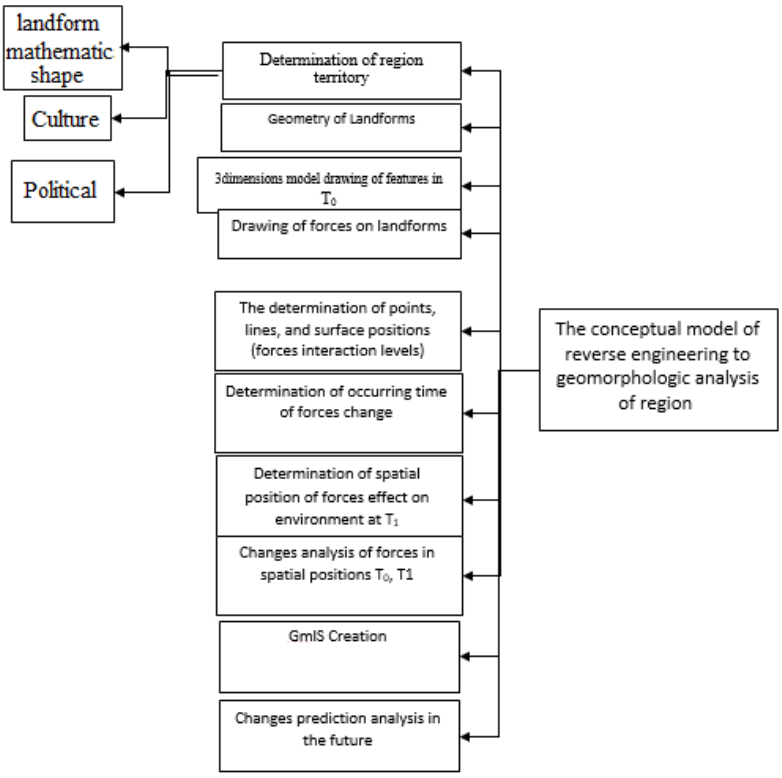

Figure 1: The conceptual model of REG

2. Description of REG conceptual model options

2.1 Determination of the studied area range

In this flowchart to start, at first the constraints must be specified using one of the mathematics, natural (basin) or political provisions that each one is described below:

2.1.1 Determination of the range using a mathematical method

In this approach, the region can be determined based on mathematical geometry of features, for example, to determine the lake range , circle drawing (or close to it) or for the river, a certain buffer of river terraces, used to determine boundary .

2.1.2 Determination of the range using natural methods (basin area)

In this method, landforms are specified based on the basin area. The basin area determined through topographic maps and DEM (Digital Elevation Model).

2.1.3 Determination of the range using political methods

In this method, the boundaries determined based on political divisions without being affected by the topography of the area. The case is determined according to the researcher views and region topography and basin area are not effective on them.

2.2 Determination of the landforms geometry

In REG model, the geometry for all features considered in three-dimensions and planar geometry is not defined for it. In principle in REG model , there is no absolute planar feature and is not defined and features that are not in three dimensions can be considered in 3 dimensions by devoting an initial value of zero (Z = 0) . The features geometry is composed of point, linear and surface topology but in some landforms, the features geometry selected as combinational due to temporal and spatial intervals that is considered as the fourth type, i.e., complex. Also, the selection of the type of features geometry depends on spatial interval of the research feature ,it means that point features, such as mud volcanoes can be considered superficial if they would be investigated locally .

This division has been obtained by vertical looking (vertical profiles) to feature such that if you look at to feature from horizon (horizontal profiles), feature geometry may change ,for example, dyke feature considered almost as points and in horizontal look as linear. And if the analysis scale is large, this feature can be investigated as superficial.

The features geometry is shown in Figure 2.

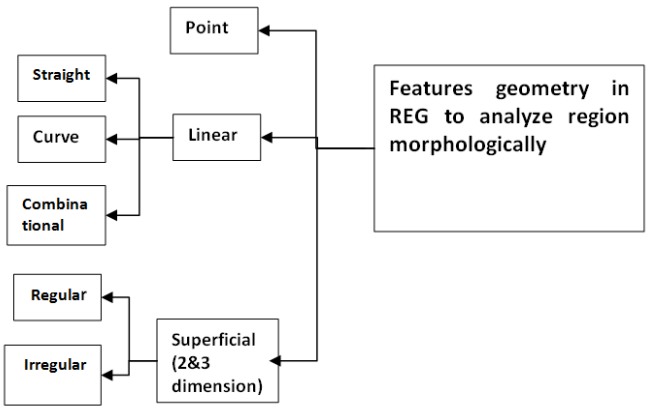

Figure 2: Features geometry in REG

2.3 Drawing of features three-dimension model

At this stage, features are drawn using associated software in three-dimensions and the position of each feature can be drawn in appropriation to the entire region, it means that the region studied in terms of topography. The aim of this work is putting the basic computing level for investigation and subsequent analysis that other changes and analysis measured in appropriation to the computational level and ancient changes as well as future changes can be surveyed according to it. The drawing can be seen in the present time T_0 and long-term changes are shown as $T_1, T_2, T_3, \ldots$ and forthcoming changes as $T_1', T_2', T_3', \ldots$.

For geomorphological analysis of region, it is required that each feature be studied and each of features put in a reverse engineering cycle and morphometric changes are obtained. It should be noted that in this cycle, some features have more severe morphometric changes than others and some have no changes or less severity. The output of this stage is as topographic and geomorphology maps.

2.4 Drawing of forces on features

Identifying the force physics is surveyed from the direction and intensity of forces. Different forces applied on each feature in micro- or macro scale that some of these forces become active in different time intervals and reach to its critical level and reshape the feature. The time parameter has importance in force survey because the effect of some great forces in short periods of time is negligible and creates minor changes in the form and geometry of the feature and vice versa. By better understanding the forces and the effectiveness of them, future changes can be modeled and predicted.

2.5 Determination of the position of points, lines and surface of forces interaction

For each feature in the specific geometric position, the resultant force reaches to its maximum value that the understanding of the situation in REG model is important for further analysis and mapping their effectiveness. For example, in a trench, there are multiple layers of sediments of various sizes that the texture of each layer and the next layer is separated and in almost uniform layer it can be said that process and equal force applied in the

certain time interval and as soon as the force and environmental conditions change, layer texture changes. The border of the environment and force change in REG model has importance in order to define the secondary topology.

2.6 Determination of occurring time of forces change

The force changes determination can be detected from changes in texture, geometry, type. The time of these forces occurring can be estimated exactly as relative or absolute by measurement of years. In calculation of changes in time, landforms changes, the rate of changes, compared to the basic time T_0 are useful. T_1 time related to force F_1 that $\Delta t = |T_0 - T_1|$ has distance to initial time (T_0) can be considered as basic time for the time before it, i. e, T_2 .

2.7 Determination of the spatial position of forces effect on the environment in Time T_1

Each force affects on the environment and being affected by the environment in a spatial position according to its intensity that the greatest effect is on the focus of environment (point, line or surface) and by going away from the focus, the effect will be less. With knowledge of the spatial environment and force, the interaction between the force and the environment can be analyzed. With spatial position, the changes on the environment can be studied in the present or future.

2.8 Analysis of the changes in forces in 2 spatial positions T_0, T_1

Initial levels at the time T_0 and lower levels at T_i have the time difference Δt , which in the time interval some changes occurred that turned lower level to the initial level (or superior) for previous changes. In this interval, the number of processes applied on the lower environment and caused changes in the lower forms. These forms and processes are known using some laboratory, field, and library works and archeology.

2.9 Creation of GmIS (Geomorphological Information System)

Geomorphological Information System (GmIS) as a special type of Geographic Information System (GIS) focused on collecting, maintaining and analyzing geomorphic information is an excellent tool for geomorphological analysis. This idea (GmIS) has been mentioned by several authors (e. g. Barsch, Dikau 1989, dikau 1992, Minar 1996, kusendova 2000, vozenilek et al. 2001). However, some problems remain which we would like to solve.

The structure of the physical model follows the logical model and is divided into three parts:

Adopted layers (hydrology, geology, topography and others), basic layers (elementary forms, digital elevation model and derivatives, documentation materials, genetic groups of landforms, morphodynamic phenomena, basin based features and geomorphic network) and special layers (morphostructural analysis, comprehensive geomorphological analysis and so on) (Mentlik et al., 2006)

2.10 The analysis to predict changes in the future

In REG model with possessing landforms geometry components, the forces acting on landforms, and descriptive characteristics in various APECs, the landforms movement path from the past to present can be simulated, and by determination of path and T_i' , the movement rate and direction of landforms movement can be modeled at time T_i' , in other words, landform position can be simulated in the future.

3. Tools and data

To implement the reverse engineering geomorphology, data and tools are needed to be able to model forces acting on landforms and also apparent geometry of landform .for the apparent geometry of landforms , 2 models of DTM (Digital Terrain Model) and the DEM (Digital Elevation Model) used. In DEM only parameter Z (height) of area with high precision is achieved but in DTM, all three components (X, Y, Z) of region from land surface are displayed. In this model, the artificial features surface is not displayed, but normal surfaces of land, i.e., dry lands, lakes, rivers are shown. In another model called DSM (Digital Surface Model), artificial features surface is shown. To specify a range, the satellite images are viewed and different maps used that output accuracy of REG model depends on the accuracy of input data. To determine the time, carbon-14, OSL (Optically Stimulate Luminescence), TL (Thermo Luminescence) methods, uranium-lead method and other methods can be used.

Also to explain and model the internal and external forces, the laws of physics, hydrodynamics, tectonics, gravity are used which vary according to the location of region. For better forces, engineering software, simulation software, programming can be used.

4. The method of implementation

According to the velocity- movement relation (Halliday et al., 2013), $\vec{x} = \vec{v} \times \vec{t}$, that is composed of the three vectors of movement, velocity and time, third vector can be obtained using 2 vectors.

By mathematical modeling of feature, it can be considered as a rigid body and all forces acting on it be modeled and obtaining the intensity and direction of the forces, their resultant forces are estimated.

Then, calculating the mass of landforms, its acceleration can be estimated. By knowing acceleration, landform movement velocity can be estimated .Finally having time and velocity, the landform movement would be estimated (following relations)

$$\begin{cases} \sum \vec{F} = m\vec{a} \\ \vec{v} = \vec{a}t \\ \vec{x} = \vec{v}t \end{cases} \quad (1)$$

In this formula, x, v, t, F, a , respectively, are acceleration, force, time, velocity and movement. Since the forces acting on the landform change constantly so the landform movement is accelerated .landforms have variable direction and velocity over time so have accelerated movement. Used time in REG dependent on the type of implementation (regressive or progressive) is as follows.

This means that present time regarded as the base time (zero) and used as an observation and also by help of it and other observations, landforms can be modeled in the past .Finally, based on landforms details in the present and the past ,the landforms situation in the future can be predicted.

5. The division of time

In REG method, the time parameter is defined according to following diagram and consisted of 3 parts of basic time T_i, T_0, T_i' which are related to the past, present and future. It is better that these times be related to fundamental changes in the geometry of landforms, the layers texture.

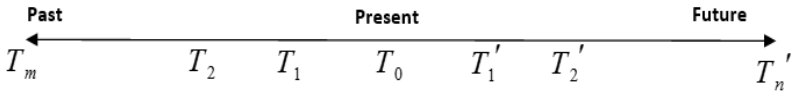

Figure 3: The division of time in REG (the authors)

REG model has errors in proportional to the accuracy of the input data. Among effective errors in modeling REG, carefully dating, mapping precision, landforms boundary determination accuracy, precision of experiments, drawings precision can be mentioned. Which must be modeled from rules of errors report and the error rate balanced. (Ranjbar and Hajizadeh, 2016)

7. Conclusions

based on REG concept, it can be said that geomorphology unknowns consisted of the three vectors of displacement, velocity and time, which show the same relationship $\vec{x} = \vec{v} \times \vec{t}$ that some vectors are in unknown different positions of research. REG model can be presented as integrated and comprehensive way to simulate geometrical and physical landforms. REG method is a tool to predict changes in landforms. If in the REG model, data and detailed log information be introduced, it can model the evolution of landforms in an engineering approach and by modeling landforms and future changes, finding location and land use and land preparation in the region are implemented.

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