Valuing Processes of Flood on the Coastal Regions of the Kur on the Basis of Data Remote Sensing

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***Abstract*— in this work have been defined the area of inundation the coastal regions of river Kur, which remained under water after inundation. Also, on the based the GIS-technologies, space image, and digital elevation model, depending on water-level, was defined the areas of territories, which will be remain under water.**

Keywords*— *GIS; space images; river Kur; flood; inundation; remote sensing

I. INTRODUCTION

In the last years was increased the number of natural extraordinary situation for the reason of natural and man-made events and of global change of climate, and in the result, inflicted significant damage and casualties to population and territory.

One of such process as is flood. Floods are destructive natural events, takes first place among of extraordinary situation, to the area of distribution and the annual property damage, to population and territory. People fight with flood from ancient times. During this process, the dam is destroyed, the flood, begin the great harm inflict to population and territory. Also, in recent years in the world was increased the number and extent of flooding.

In the spring because of the snow and rain and in the autumn because of the rain water in the river Kur is rising the level of water, flood risk is increasing, in the result coastal region of Kur remains under threat of flooding. Because of this reason in Azerbaijan people always suffer from floods. Flooding is inflicting the great damage to the agricultural sector of Azerbaijan, because, the part of population and field of economy, is remained in the zone of danger of flooding.

In 2007, and May - June in 2010 the level of water in river Kura was increased and as a result was flooded residential areas, which are located in the vicinity of the Kura. After flooding, in the 40 regions of Azerbaijan more than 30 living area, 110 hectares of arable land and pasture remained under water. Flood inflicted the great harm to public, manufacturing, teaching and educational centers, whole of the infrastructure. Thousands of people forced to leave their houses and are live to the administrative building, a tent.

The problem of forecasting and modeling of natural and man-made disasters is now one of the most important and actual theme. In particular, the risk of emergencies related to flooding, remains very high, continues to increase the number of victims and economic losses from floods.

Now this century called of information technology, and therefore, such processes have to study with the help of modern technology. Therefore, main purposes of this work are assess floods in surroundings areas of the river Kura, on the based of integration modern technology and space images, to determine the areas of flooding and area of territories, which remained under water during floods. Also, on the based the GIS-technologies, space image, and digital elevation model, depending on water-level, till flooding define the area of inundation territories, which will be remain under water *and to give the information and forecasts to the public*.

II. PROCESS OF THE WORK

In this work, the whole process of work is shown in the following schemes (Fig.1).

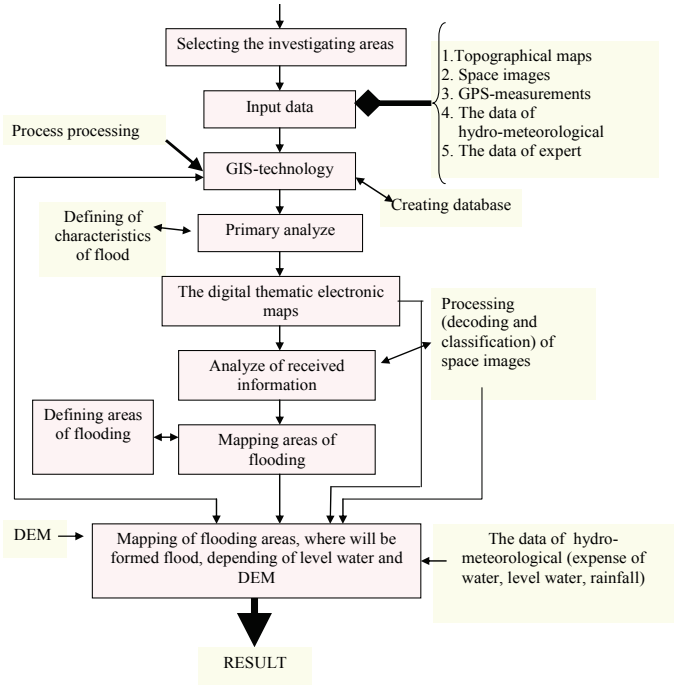


Figure 1. Process of implemented of the work

Areas of investigation

As areas of investigation have been taken the coastal zone the river of Kura of Azerbaijan (Fig. 1).

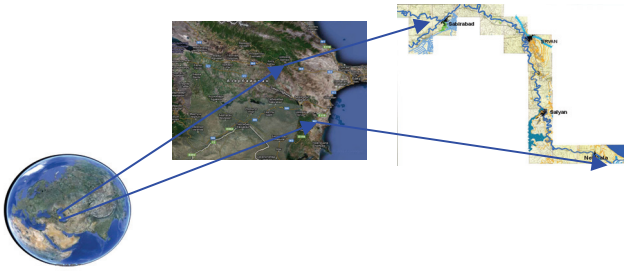


Figure 2. The structural scheme of areas of investigation

The input data

To conduct research in the coastal zones of the river Kur, we had used information, which received from different information sources, including topographic map with a scale of 1:25,000, GPS measurement, the meteorological data, space images Terra Modis with resolution of 250 m, Landsat-TM, which describe the studied areas. And also was used the software of GIS- technology (Arc GIS, Erdas Imagine).

The causes of flood and inundation

We know, that flood and inundation are forming in most cases after prolonged, intense rain. But sometimes, for reasons of natural and anthropogenic factors are starting to flooding. Therefore, in this work have studied and analyzed all materials, which received from processing the space images, of the meteorological data, of statistical data, and ground-based GPS-measurements. Received information (all the natural and man-made factors) had been analyzed, grouped and systematized as table and was added to the data base of GIS (Table 1).

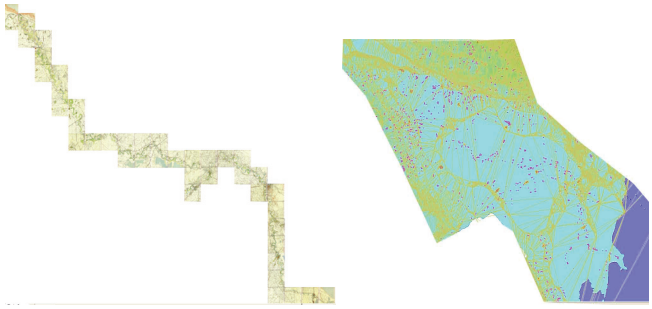
TABLE 1. CAUSES OF THE FLOODS AND INUNDATION ON THE COASTAL ZONE OF THE KUR

N	Natural factors	Antropogen factors
1	Falling of the prolonged, intense and pouring rain	Catastrophe happens in the dams and as a result is destroyed some of the dams
2	Critically changing of the climate	Does not cleaned the silts of the river-bed of the rivers
3	Quickly untimely the melting of snow and ices in the source of the river	Narrowing and shallowing of river-bed
4	The beginning of rivers is accepting in more quantity water and therefore river-bed of river can't taking of this water mass	With decrease of the depth of the bottom of the delta of the river capacity tonnage of water are decreasing
5	Increase of the level of the waters of soil	Creation of the artificial dams
6	With the causes of turbid the river-bed and delta of river is diminish of the ability of the discharge of water	At time of constructing the building at the coastal zone of river Kur one of the part of the dams remains in the inside of the villages
7	In the spring time in the narrow places of the rivers are gathered many ice and this process is interferes to the flow of river	Expenditure, which being intended for liquidation of the results of inundation, is more expenses, which being intended for his prevention
8	Gathering of much water in the water reservoir of Mingachevir	The irrigation work is carried out badly
9	The water, which is entered into the Kur, more than of the water, which go out from the Kur	

The digital elevation model and creation the digital electronic maps

Topographical maps (scale:1:25000) was processed with the help of the GIS program, was done georeference. Carrying out work have been implemented with projection of UTM (Universal Transverse Mercator) and with the help of the system of co-ordinates WGS 84. All elements of space have been brought to the unity of cartographical projection (Fig.2 (a)). With the help of GIS-technology have created a digital electronic maps of the investigation areas.

And then is been created digital elevation model (DEM) with using topographic maps of the investigation region and the software Arc GIS (Fig.2(a)). Because the main base of areas, where are happened floods, are forming DEM, data RS and topographic map.



a) b)

Figure 3. a) Topographical maps of investigation areas, b) digital elevation model

A database on the gathered information was created (GPS-measurements, DEM, topographic maps, statistical data, hydrometeorological data). Information that's was collected in a database, have been used to create the thematic electronical maps. A digitization of topographical maps was carried out and a different digital thematical maps (Fig.3) are created

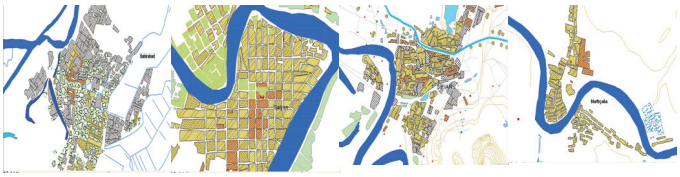


Figure 4. The digital electronical maps of region Sabirabad, Salyan, Shirvan, Neftchala

Process treatment of space images

Determination of floods on the rivers is one of the most important areas of applications of space information of high and medium resolution. To get more information about the floods can only with data of remote sensing. The method of mapping floods was based on digital processing techniques of space images in different scales obtained from satellites in the optical and near-infrared channel.

In order to assess the flood, was used of the space image from Terra Modis resolution of 250 m, to the flood (21.04.2010), during the floods (21.05., 22.05, 23.05, 24.05,

25.05, 26.05, 27.05, 5.28, 5.29) and after the flood (01.06) (Fig.4).

For processing, was used the space data in digital form, because, those images had obtained from the archive in digital form.

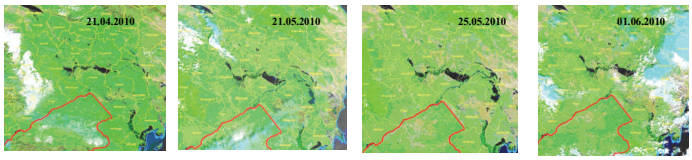


Figure 5. Space images Terra Modis for coastal zone of river Kur, in 2010 year, to the flood, during the flood and after the flood

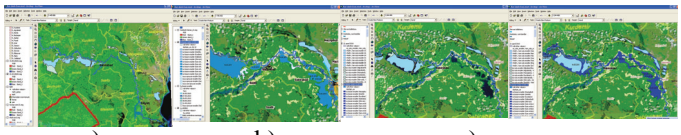
This images was translated to UTM projection and was made-to-one coordinate. Was used polynom of one extent and 30 supporting points. Was defined etalon classes, and was carried out the decoding on the structure and tone of space images. For interpretation and decoding of images to separate them to the part of inundation and waterless (dry), was defined the difference of brightness of the water and land.

The difficulties of interpreting and decoding of the water surface due to the fact that in some cases the brightness of water and land intersect, that is, the identical brightness may correspond to both flooded and waterless (dry) layers. To remedy these difficulties was used the near-infrared range. Because, that differences is clearly manifested in the near infrared range 0.8 -1.0 mm.

And also for reduce of the differences was carried second classification on the space images. During the second's classification was used channel: 4, 5 and 3. These channels is called: near infrared, middle-infrared and visible red. During the connection of these channels, could defining difference between water and land, was been clarified the place of inundation, that could not be to divide visible channel.

Mapping of the territory, that remained under water during floods and to determining their area

After processing, the all space image had been combined with digitally electronically maps in GIS technology. Using these space images, was determined the place area and the flooding and of their area, which began in April 21 and May 14, 2010 in the Sabirabad, Salyan, Shirvan and Neftchala (Fig. 5 and Fig.6).



a) b) c)

Figure 6. The areas of flooding in the coastal zon river Kur, in time flood, in 2010 year: a) 21 april 2010, b) 14 may 2010, c) 21 april ,and 14 may.

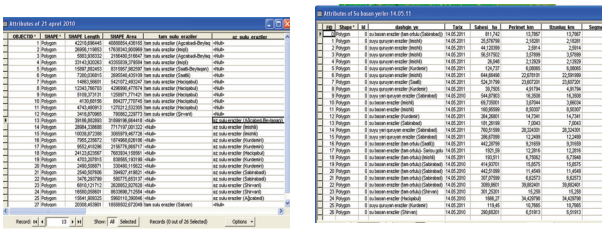


Figure 7. The flooding and of their area in 21 april and 14 may 2010 year in the coastal zone of Kur (picture was taken from database of GIS)

And also on the basis of the processed images was been defined of territory and the area of inundation in time of 25.05.10 - 30.05.2010, during the floods in coastal areas Kura (Imishli, Sabirabad, Shirvan, Hajigabul, Bilasuvar, Saatli) using GIS technology (Fig.7).

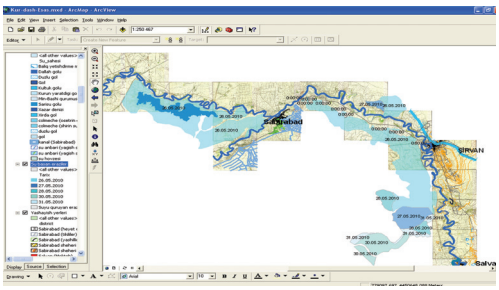


Figure 8. Areas of inundation in the regions of Imishli, Sabirabad, Shirvan, Hajigabul, Bilasuvar, Saatli, during flooding

The all area of inundation: Imishli – 14500 ha, Sabirabad – 44050 ha, Shirvan – 25 ha, Hajigabul – 2300 ha, Bilasuvar – 125 ha, Saatli 9100 ha.

Methods for mapping and determining the areas of flooding , depending on water levels

In the proposed method, till the flood, is possible to determine the location of flooding, depending on water levels and on the DEM. To do this, was used a DEM, which was created with the help of relief and space images (Fig.8). Based on the model of the DEM was defined, moist, convex and concave parts of the territory. Also used meteorological data to create the model. This data was added to the DEM.

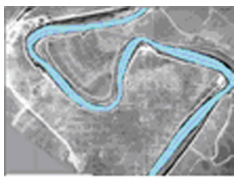


Figure 9. DEM for the territory of Salyan

If in the region of Salyan, will be happen the floods, based on water level and DEM, may to determined the inundation area and to calculate their area and thickness of the water surface. In picture shown, the left and right part of dams of near the river and bathymetric characteristics of the river. As a result of bathymetric measurements determined, that if evaluated the level of water, if the absolute level of water reached up to - 21 m (4.18 m), the water in the river reach to the level of the right shore line. At this time, depending on the

strength of the protective dam, the water will be flooded particular territory. If it is as, then the flooded area is shown in Fig. 9.

Figure 10. According to the level of water, was showing the flooding areas in Salyan.

If the level water of investigated territory reached up to - 21 m, by calculating the number of pixels in the flooded areas using GIS technology, we can determine the area of inundation areas (Fig.10).

Attributes of Su basan erazi (Salyan)

FID	Sha	I	Erazi	Sahe_ha	Perimet_km	Uzunluq_km
0	Poly	0	Salyan	3,30329	1,38663	1,38663
1	Poly	0	Salyan	22,3748	6,25152	6,25152
2	Poly	0	Salyan	1,45498	0,861928	0,861928
3	Poly	0	Salyan	0,190928	0,195183	0,195183
4	Poly	0	Salyan	21,2167	4,61148	4,61148
5	Poly	0	Salyan	0,586539	0,424925	0,424925
6	Poly	0	Salyan	0,365542	0,327894	0,327894
7	Poly	0	Salyan	0,523239	0,309093	0,309093
8	Poly	0	Salyan	1,50285	1,28436	1,28436
9	Poly	0	Salyan	0,052206	0,105437	0,105437
10	Poly	0	Salyan	0,069837	0,126946	0,126946
11	Poly	0	Salyan	0,051354	0,087873	0,087873
12	Poly	0	Salyan	2,49152	1,08959	1,08959
13	Poly	0	Salyan	0,708685	0,61837	0,61837
14	Poly	0	Salyan	0,337765	0,343445	0,343445
15	Poly	0	Salyan	0,206966	0,196775	0,196775
16	Poly	0	Salyan	1,5946	1,46737	1,46737
17	Poly	0	Salyan	21,7232	2,50889	2,50889
18	Poly	0	Salyan	5,43373	2,4236	2,4236
19	Poly	0	Salyan	7,98559	7,98559	7,98559
20	Poly	0	Salyan	0,258013	0,250845	0,250845
21	Poly	0	Salyan	10,1892	1,36486	1,36486
22	Poly	0	Salyan	10,1659	1,36441	1,36441
23	Poly	0	Salyan	12,6058	3,3659	3,3659
24	Poly	0	Salyan	3,63581	0,893103	0,893103
25	Poly	0	Salyan	5,97642	1,86905	1,86905
26	Poly	0	Salyan	16,428499	3,44733	3,44733
27	Poly	0	Salyan	6,75222	1,01222	1,01222
28	Poly	0	Salyan	2,31792	0,658136	0,658136
29	Poly	0	Salyan	0,249431	0,190904	0,190904
30	Poly	0	Salyan	6,17856	0,936703	0,936703
31	Poly	0	Salyan	0,066649	0,100695	0,100695
32	Poly	0	Salyan	0,039807	0,083067	0,083067
33	Poly	0	Salyan	0,165435	0,169726	0,169726
34	Poly	0	Salyan	0,347879	0,902076	0,902076

Figure 11. The area of the territory, remaining under water

III. CONCLUSION

Thus, the result in this work, had been generalized and systematized below:

1. Digital electronic maps was created for the investigation region;
2. A digital terrain model was created
3. Was created the different thematic layers of the infrastructure of the investigated region.
4. Was processed (decode and classification) space image.
5. The factors for the formation of floods in the coastal zone of river Kura was defined.
6. A database in GIS was created.
7. Identified and was mapped area of flooding and coastal area in the Kura during floods and was been computed of area inundation of investigated region.
8. In the proposed method, with use of level of water and DEM, was defined the area of flooding and was been computed its area (till flood in the coastal zon of Kur).

As a result, we can say that with the definition of flooding areas and computed its area, with the definition areas of flooding to the flood, depending on water level and DEM model (till flood in Kur), we can to help and warn people of threats of flooding. We can show people that in the protective coastal lines can not build houses for a living, during the damage of dam is necessary to repaired dam, etc.

The developed computer technology designed for rapid modeling and assessment of flooded areas of settlements under the threat of flooding caused by natural factors as runoff. The results obtained using the developed computer technology, information can serve as support for decision-makers in the formulation of complexes of various measures to prevent and reduce the negative effects of floods.

This method was designed for rapid modeling and assessment of flooded areas, which is under the threat of flooding caused by natural factors as runoff. The results obtained using the developed computer technology, can serve as support for decision-makers in the formulation of complexes of various measures to prevent and reduce the negative effects of floods.

REFERENCES

[1] N Kussul, A. Shelestov and S. Skakun, "Grid System for Flood Extent Extraction from Satellite Images", Earth Science Informatics, vol. 1, 2008, pp.105-117.

[2] Sh..Muttalibiva., N. Pashayev., R. Ragimov and G. Qashimov, "Simulation destroying of dam for assess of inundation zones", System Analysis and Information Technologies. International Conference SAIT 2011, Kyiv, Ukraine, May 23-28, 2011.