VULNERABILITY OF EAST IRAN RAILWAY AGAINST FLOODS

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ABSTRACT: Railways of Iran especially in arid regions has been damaged of flooding recently. Most of the flood damages were happened on the bridges railway. The main reason can be found in the context of changes in riverbed, sudden heavy rainfall, and coarse sediment. Dasht-e Lut and Dareh-Angir basins in the East of Iran are flat and covered by Salt land that the railway network goes through the north of the area. Length of Railway in the study area is 220.13 km and areas of catchments are 8641.27 Square kilometers. There are a lot of watercourses. Due to the abundance of coarse sediment and flatness, the streams are changing their bed in this area. Thus, more bridges are prone to flooding and runoff. The goal of this research is to assess the railway vulnerability of flood. Data sources were used in the research consisted of two parts: the first part of the data is international Database and the second is the data from 1:25000 topographic and elevation data of Aster images. They have been replaced to increase the spatial resolution of these data. Also 23 samples were taken of sediment under bridges. This research was conducted in two stages, in the first stage a Surface Tank Model, of a set Distributed hydrological modeling, was used in Integrated Flood Analysis System (IFAS) software. The model consists of a surface reservoir to surface precipitation, the average flow velocity and infiltration flow. The second phase Indian Council of Agriculture Research (I.C.A.R) model has been used to evaluate the results. The IFAS results showed that 70 percent of the railway between Robatposhtbadam to Khonj stations, Jandagh to Chadormaloo and Chahmohammadu and also part of Raml to Jandagh which the whole railway 220.13 kilometers faced to flooding and runoff.

Key Words: Railway, Flood, Dasht-eLut, Dareh-Angir, Iran.

1. INTRODUCTION

Today, there are numerous reports of spate damage on the lines and the railway. One of the first reports of spate damage in railways is in Medway River in Kent region, England on 20 January 1846. The spate caused the stop in the movement of the rail on the track and the locomotive driver passed away (Reed, 2004:212). One of the newest report in this regard was happened in the Bangkok Thailand Railways in northern and central Thailand in October 2011, Seasonal rains caused many parts of railroads soaked and trains which moved from south towards the center of Bangkok were stopped or moved irregularly (according to Student Agency).Unfortunately sometimes in our country spate destroyed some parts of the railway tracks and has stopped moving too. Hereby we bring some examples to notify this point. In July 2010 three rail route of Tehran – Mashhad, within 20 km from the Bastam station - Gillan station in Shahroud city were destroyed by the spate (Mehr News Agency, 2010). Annually in arid territory of Iranian Railways, spate has so much damages. The most damages are on bridges built over streams, and the reason is the changes on bed in streams, sudden rains and also the discontinuous material in this area. Also, because there is no base flow, the spate in arid and semi-arid areas usually are short and are affected by the rain degree. Dryness in bed of river, the leveling the earth, and lack of plant coverage cause streams change their beds annually or seasonally. The bed changes, railway bridges destruction, levee collapse, bridge clogging by sediment and water uplift and thus causing damage to rail tracks and its structures .so the spate prediction in desert and dried area can largely reduce the damages. Of course it should be mentioned that problems such as rapid increases in river flow, carrying large amounts of sediment, the changes in levels of river stage, lack of control levels and sudden rains, prevent to do excess flow measurement by hydrometric stations in dry areas. However, the development of integrated systems for analyzing spate to reduce spate risk and minimize human injuries in different countries, particularly in areas where river basin modification are required..meanwhile The problems of developing countries in these systems, including installation and maintenance of monitoring stations to forecast and warning systems, Because these systems need to collect rain data in the upper part of the river and access to the up to date data too. Using satellite observations (Earth Observation Satellites) EOS calculation and prediction of runoff and flood forecasting and flood warning systems without doing ground-based observations can be available. Although there are some problems in using these data such as the number of measurement points, the rainfall rate, especially in arid area of Iran and also irregular rainfall in Iran too. However, using the data of topography , geology , soils , land use proper forecasting and estimation models for better forecasting and spate warning systems , to create such systems is promising (Reed, 2004). In this study we try to evaluate the vulnerability of railway lines north of" Lut" plain , in the spate , the spate integrated systems (IFAS) provided by the International Centre for water hazard and risk Management , in collaboration with UNESCO, ICHARM and PWRI, digital data by satellite data is collected and used in the models and algorithms of the program works. Algorithm used in the study of distributed hydrological model is based on physical equations with semi-empirical equations are rainfall and adjusted (ICHARM, 2009).

2. THE STUDY AREA

The study area includes the northern part of the basin in "Lut" Plain and politically part of Yazd province. Length of railway lines in the study area is 356.37 km. There are 20,251.98 square kilometers (Figure 1) .by topography point of view Lut Plain, is relatively low-lying area and the central plateau and it is a vast area of low mountains to the North and North West, scattered desert land in the foothills that separate the salt desert . Maximum altitude in the western of the area is 4233 m , in the southwestern mountains of 'Hezar" 4465 m ,in "lalezar" 4350 m, in south of Karan mountain 2450 m , the mountain of "Bazman" 3489 and 4042m in "Taftan" mountain . in noth of east and high lands in east and north of "Birjand" and "SAdeh"the maximum height is 2633m. Meanwhile in west of north in east of "Tabas" the max height is 3250m."Lut" pain which has average height of 500m is a is a very broad area with low slope. It is covered with big and small salt marshes and the north railway network passes from this area(Figure 2). As Figure 2 shows the change in height of the rail lines around the basin is This network range is not permanent and occasional seasonal runoff and drainage are guided from the northern and western parts to rail and also drainage network accidently by the help of 930 railway bridges passed the railway tracks.Overall, the number of watercourse in the area is high, the beds are changed every year and therefore it is difficult to control runoff in this area.

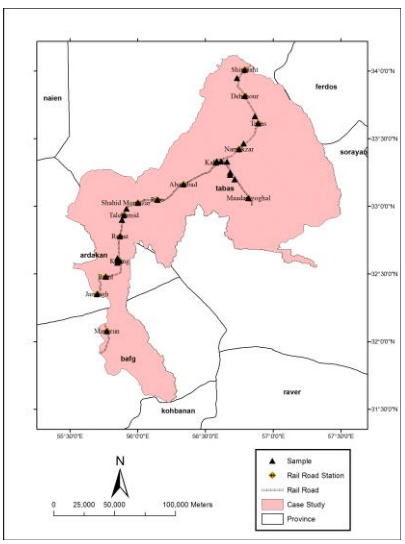


Figure 1: Location of the study area.

3. MATERIALS AND METHODS

Data sources used in the study consisted of two parts: in the first part of the up to date data when it is used IFAS programs related to international sites and second, to increase the spatial resolution of these data with data from 1:25000 topographic, and elevation data Aster pixel dimensions of 30 m has been replace.Precipitation data at sites containing data extracted from GS MaP (JAXA) cover-area, elevation data sources, hydrology, land use extracted from GTOPO30 (USGS) with enlarge 30 seconds, land-use GLCC (USGS), Hydro (NASA) Spatial resolution with pixels of 1 km and Global Map (ISCGM) Spatial resolution spatial resolution is 30 seconds at, et.2009 (Fukami).

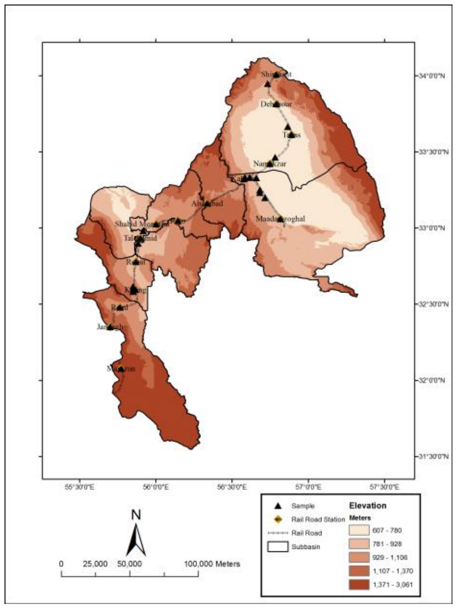


Figure 2: Models and changes height in the study area

This study was conducted in two stages, the first stage of a shallow reservoir model, a series of distributed hydrological models, is used in IFAS. The model consists of a superficial reservoir to surface precipitation, the average velocity of influx (Fig. 3). Output in the form on the right shows the area average velocity of flow through the earth. Waterways that were crossing the tracks were removed. The aggregate survey, 50% of the particle diameter (D50) channels is divided into 8 classes and roughness coefficient was calculated according to the method Dry and Garrett. (Aldridge and Garrett, 1973) (Barnes, 1967) (Table1). Unsaturated subsurface flow speed was estimated as part of the storage capacity. The Earth Influence as a part of the storage capacity was estimated based on Darcy's law (Sugawara, et. al., 1983) (Feldman, 2000),.(Limerinos, J.T. 1970).

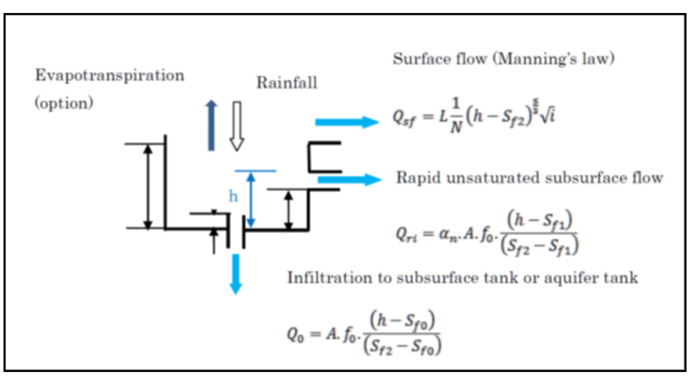


Figure 3: Schematic flow model level (IFAS System Instruction Guidebook, 2011:13)

The model components include: R rainfall, Eps evaporation, Q0 Penetration into the lower reservoir, Qsf Surface Flow, Qri Unsaturated subsurface flow, ، h height of the water reservoir, Sf2 and Sf1 unsaturated subsurface reservoir the height of water, Sf0 high water permeability and A = L * L is the length of the mesh network to estimate the area.

Table 1: Manning roughness coefficient (Arcement, and Schneider, 1986)

Sample	Manning roughness coefficient	Particle diameter (mm)on D50
	0.012	0.2
	0.17	0.3
	0.20	0.4
	0.22	0.5

	0.23	0.6
	0.25	0.8
	0.025-0.032	1-2
	0.026-0.035	2-64

To evaluate the results of the second phase of the Indian Society of Agricultural Research (ICAR) has been used. The equation is as follows.

$$R = \frac{P^{1.44} * A^{0.63} * \Delta H^{0.66}}{15.19 * Ff^{2.05} * La^{2.05} * T^{1.34}} \qquad [1]$$

P and R, respectively, annual rainfall in centimeters, A catchment's area in terms of square kilometers, HΔ maximum height in meters of the basin, Ff basin shape factor, T the mean annual temperature according to Celsius, and during La per km main channel (Tolson and Shoemaker)., 2000. ICAR model in this study is used to physiographic conditions and rainfall runoff in the model. Determined based on the latitude and longitude coordinate data Shmallvt the elevation of the site Global Map (ISCGM) were extracted. Drainage elements such as Alqr line, network River basin and the elevation data using the help of Aster Data were extracted (Fig. 4). The data relating to users of the site GLCC (USGS) has been harvested (Figure 5). Lot area is made up mostly of desert regions and a small fraction is devoted to other users. Rainfall layers of the site QMORPH, CMORPH (NOAA) cover-area in the range 60 degrees latitude north and south were extracted. The surface flow model was implemented. Analytical results for anywhere from railway lines were evaluated with field observations.

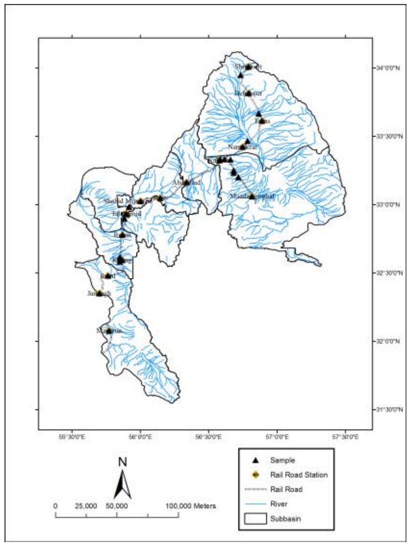
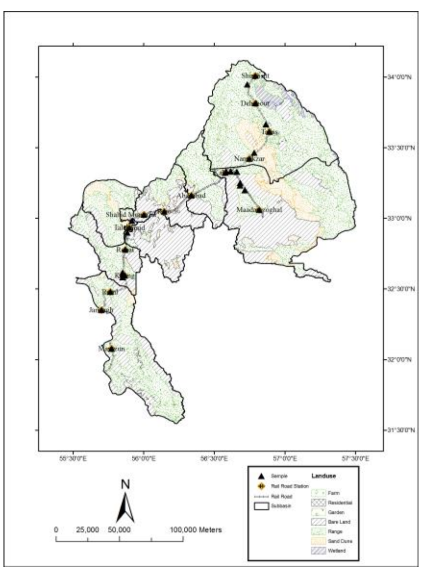


Figure 4: Drainage network extracted from IFAS

4. RESULT

The results IFAS shows that the total 356.37 km e of railway and watercourse and stream them to cross 930 bridge, the 47,21 km from the railway between stations Tabas to Namakzar, Robat Poshtebam to khonj as part of Romal to Jandagh that with 107 bridge, are prone to flooding and Bgrftgy . 49.75 miles from the line of distance between stations Shirghesht to so after Dehshor and Tel Hamid to Robatposhtebam so that the bridge is 111. Are potentially at risk of flooding (Figure 6). Runoff compared with the results obtained from the ICAR model showed that the risk of runoff is the maximum height of the total annual runoff greater than 100 cm in height (Figure 7). Annual runoff in areas where they are not uniform and rain for much of the annual rainfall degree to get seasonal or casual.



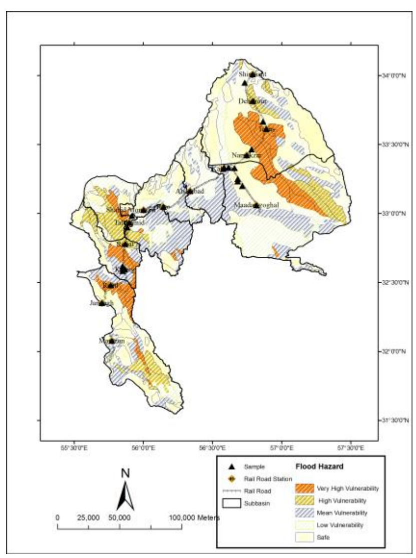


Figure 5: User data extracted from the GLCC (USGS) from IFAS

Figure 6: Critical points of concentrated runoff

The results of field observations in high-risk areas between station Tabas to Namakzar showed the different flood damages. Figure 8 shows the Tabas station that has a bed of sedimentary rock layers, especially marl and conglomerate. This region has topography of hills; the material is loose and detached of Vasily extreme Floodwater. Granvlvmtry results showed that the median grain diameter of the channel (D50) is about 2 mm, which reflects the power of floods in the area.

Figure 9 shows accumulation of water under the bridge in Tabas railway in April 2012, between stations Roobat Poshtebam toKhonge and Roomal Stations to Jandagh was observed evidences of multiple floods damages. The result of granolometre in stream bed showed that the D50 is about 1.3 mm, which is indicated the severity of the flooding. When flooding occurs, in the sedimentation of solids and liquids are separated and sorted sediments have caused flooding and boundary layer are determined. Flood plain sediments in the diagnosis of sediments from other t-Track were used.The index is calculated based on the deposits of between (1.8 to 2.7) is in the flood (Costa & Fleisher, 1984). Range of scores for the 17 samples is between 2.45 to 2 (Ghahroudi 1391). This indicates that the sediments accumulated under the bridges moved by floodwaters.

$$So = \sqrt{\frac{d_{75}}{d_{25}}} \qquad [2]$$

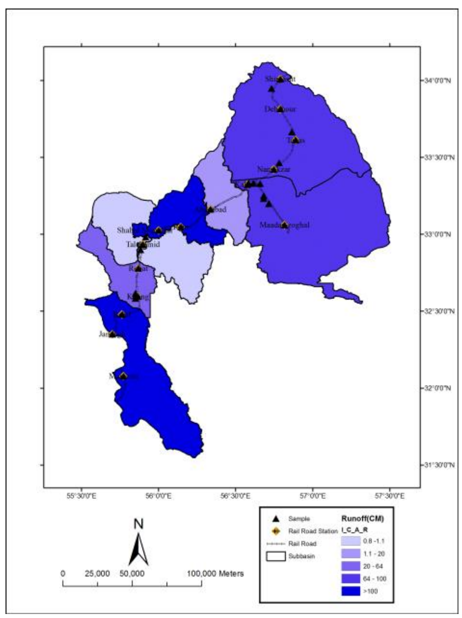


Figure 7: Distribution of runoff

5. DISCUSSION AND CONCLUSIONS

The study area is located in the East railway transport in the country is very important. This area is one of the most important parts of Iran's railway network, the rainfall damages sees several reasons It involves deposition of spate damage along the railway line, the risk of damage to the rails in a row, he was disrupting rail, road and potential hazard created by the rail road is sometimes closed. In some areas such as the grounds, construction of buildings, gardens to discern the causes of the natural drainage a superficial runoff is diverted to flow in another direction To understand the phenomenon of flooding and damage creation and the issue of the railway network vulnerable areas of the IFAS program that will take data from different satellites, has been used. Using a base map and field observations is part of replacement program information and vulnerable points in the region have been investigated. Analysis of the results indicates that the “Lut” Plain of North East railways because it is going to be located in a dry area, a phenomenon uniform distribution of the in a one-year Chance of Rain faces where 2h found to sometimes this is due to the lack of vegetation and extent floods detached material adds speed and volume. Field observations showed that the lines in the area of floodplains are crossed with numerous problems. It's not a constant stream of the bed during the precipitation will change.This change has led to the precipitation of the substrate can be reduced drainage and influx water drainage and bridges should be skewed as a result of bridges basis is exposed to degradation flood, Figure 8 and 9 represent just a stream bed. Granolomtry test samples showed that the average grain size (D50) in the scale of medium to coarse sand. For example, the bridge near the Tabas station (D50) tops size 2 mm. Figure 10 shows the cross rails as the Playa area of fine-grained minerals and have severe erosion and shallow and Rill and gully move the flood sediment volume is high, it causes the accumulation of sediments beneath bridges so railway and bridges have been damaged. Figure 10 shows that the accumulation of flooding under the bridge due to the large volume of sediments and flooded bridges and there is not any drainage facilities.

Figure 8: bed scour at bridge in Shadmehr to Torbat stations

Figure 9: Accumulation of water under the bridge in Tabas railway

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