FLOODS AND THEİR LİKELY İMPACTS ON ECOLOGİCAL ENVİRONMENT İN THE BOLAMAN RİVER BASİN (ORDU, TURKEY)

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Abstract: *Floods, causing inundation, frequently occur in the Bolaman River basin. In this study, flood risk zonation and impacts of inundation on ecological environment were investigated in the Bolaman River basin. Inundation risk zonation was carried out using Geographic Information Systems (GIS) technologies. When results were overlayed with landcover data of the study area, it was seen, that the settlement and agricultural areas in the study area will be affected by floods. Also, ecological environmental problems, such as water and soil pollutions, agricultural soil erosion, agricultural land degredations causing flood sediments as well as the ecological deterioration on living environment of natural flora and fauna will be caused by floods in the Bolaman River basin.*

Keywords: *Flood, ecology, River basin, GIS.*

INTRODUCTİON

For various reasons, floods occur in the river basin. Both the natural causes and the effects of human activities play a role on occurrence of these floods. In Turkey, that large water volumes reach flood disaster level is a natural consequence of urbanization development. Flood disasters causes loss of life and property, loss of natural resources and ecological environmental change. The Bolaman River basin is one of the most important flood basins in the city of Ordu.

The study area in the provincial borders of the city of Ordu (North 40°30'-41°00', East 37°10'-37°45') is located in the Middle Black Sea section of the Black Sea Region (Fig. 1). In terms of hydrography, Eastern Black Sea is included in drainage basin. It has a 1339,5 km² catchment area. It is about 73 km away from Samsun, which is in the west of it and 55 km away from the city of Ordu, which is in the east of it and about 102 km away from Resadiye, which is in the south of it.

In Bolaman River basin, floods having a nature of disaster been occuring every year. These floods damage not only human life but also ecological environment. In this study, flood risk analysis was made and ecological environment impacts of floods occuring in Bolaman River basin were investigated.

METHODS AND MATERİAL

In this study, flood risk zones in the Bolaman River basin were determined by using the multi-criteria decision analysis principles. Then, impacts of floods on the ecological environmet were investigated in the affected area. Multi-Criteria Decision-Analysis method is one of the systematic methods followed to solve decision problems of complex events. There are lots of Multi-Criteria Decision-Analysis methods (MCDA) that differ according to types of usage and integration of data. This method contains seperating problems into more comprehensible and small sections; analysing each of them and joining these small sections to build a comprehensible solution (MALCZEWSKİ 1997). Multi-criteria decision-analysis method can be used to determine an option that is preferred the most, to order the options, to list the limited numbers of the options for the evaluation which has enough detail, or to distinguish acceptable probabilities from unacceptable ones (DODGSON et al. 2000).

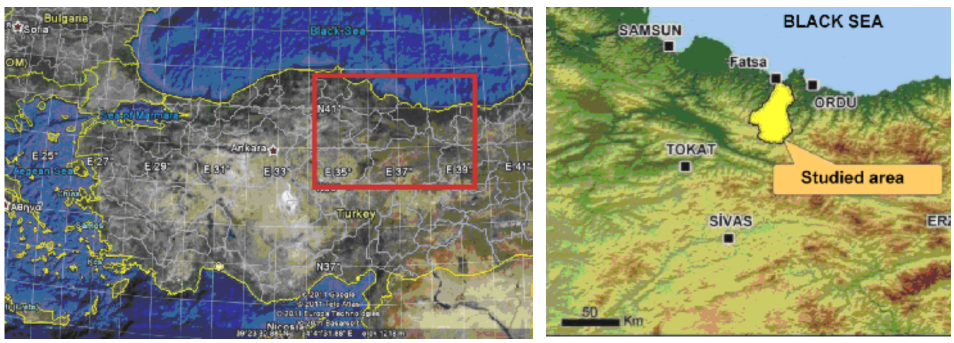

Figure 1: Location map of the study area.

Flood areas were determined for flood damages on ecological environment in Bolaman River basin. Geographic Information Systems (GIS) technologies were used for this analysis. For the production of parametric maps to determine flood zones of Bolaman River Basin; 1/25000 scale topographic maps, 1/100000 scale geological and soil maps, LANDSAT ETM +2000 satellite images were used. These basic maps, transferred to digital media, were rectified by using Universal Transversal Mercator (UTM) projection, European Datum (ED) 1950 datum and zone 36N by using ArcGIS 9.2 software. 1/25000 scaled topographic maps were digitised as 10 m in the basin-wide and as 5 and 2,5 m local resolution in the coastal zonning. Triangulated Irregular Network (TIN), height, slope, exposure, Topographic Wetness Index (TWI), Stream Power Index (SPI) thematic maps were obtained from digital data base of study area. Normalized Difference Vegetation Index (NDVI) map was obtained from LANDSAT ETM +2000 images (Figure 2). All these producted maps were weighted by being evaluated with field observations and by depending on decrement relation. Then, connected to relationship of reduction in growth, sub-units, based on parameters for risk zonning, were given 1-5 values from very little to very high. The same evaluation was also used for risk zonning.

FLOOD RİSK ANAYSİS FOR THE BOLAMAN RİVER BASİN

GIS tools provide a great convenience for determining areas affected by floods (NYARKO 2000, TUROĞLU 2007, TUROĞLU 2008, TUROĞLU 2010, TUROĞLU, ULUDAĞ 2010). Therefore, the GIS Technologies were used to determine flood risk zones in Bolaman River basin. Soil, TWI, SPI, height, slope, aspect, NDVI features of Bolaman River basin were analysed in order to determine the flood risk areas.

Alluvial soil is one of the soil groups important for the flood and ecology on Bolaman River Basin. Alluvial soil is mostly available on the fields such as valley bottoms and coasts whose slopes are low and on which the water can be ponded. In addition to the slope features, the risk of flood has been accepted as high in terms of texture and structure (Fig. 2).

TWI shows the places around which water can hang. In the places whose TWI values are low, permeability is also low. In the places whose values are high, permeability is also high. After torrents, water suddenly rises by being ponded on the fields whose slope conditions are suitable and permeability is low. Therefore; in the zonning of flood risk, TWI has been accepted as a highly important parameter (Fig. 3).

Stream Power Index (SPI) indicates flow rate and abrasive power of a river. When SPI value is high, abrasive power as well as grain size of the stream load show increase clearly. The places whose value is low indicates the fields on which water and moving material will be able to accumulate. In these places, latitude edge of streambed can change. Stream Power Index has been evaluated as a parameter which has intermediate importance in flood risk zonning (Fig. 4).

The increasing height from coast to hinterland in the study area has an effect on climatic features such as rain, heat, the amount of evaporation and slope values belonging to the field. So, height has been accepted as an important parameter in risk zonning (Fig. 5).

Slope in zonning of flood risk has been evaluated as one of the very important parameters. In the place where slope values are smooth or close to smooth, water turns into a pond. The places whose slopes are low are especially the fields whose risk of flood is high. The places whose slope range is 0-2° have the risk of being a pond, thus they have high risk of flood (TUROĞLU 2007). The places which are between this slope range in the study field have a proportion of 2,7 percent. Although this slope range looks like a low proportion, it is important because it covers coastal areas and intensive settlements in the study area (Fig. 6).

The aspect factor affects some factors such as rainfall, evapotranspiration, soil humidity, cloudiness, amount of rainfall. When we calculate the the total of northern slopes, the ratio is 48,12 percent. The northern slopes are evaluated as an effective element in the rainfall's superficial flow and in the reduction of infiltration capacity because the northern slopes retain the humidity of soil after rainfall for a long time. In this study, the exposure factor has been evaluated as one of the parameters that have intermediate importance (Fig.7).

NDVI values describe the numerical indicator of the density of the vegetation on a region. Vegetation makes a different impact on both superficial flow and erosion in the fields that have different slope values. Vegetation reduces and slows the superficial flow where the vegetation is lush. This effect of vegetation gives the chance to the water to leak into the ground on suitable grounds and groups of soil, furthermore; it reduces the amount of water that flows by means of interseption. In zoning of flood risk, NDVI has been evaluated as one of the crucial parameters (Fig. 8).

Factors playing a role in flood disaster were analysed to determine flood risk zones. In second step, these results were overlaid by using the mathematical calculations in "raster calculater" functions of ArcGIS 9.2 software (Fig. 9). The result of the analysis; high risk of flood in Bolaman River Basin does not cover a wide area in the basin, but; it is remarkable that almost the whole area which is under a high risk is occupied by urbanization and agricultural activities (Table 1).

Table 1

The relationship between flood disaster risk classification and landcover in Bolaman River basin.

	Flood Disaster Risk				
	Very little	**Little**	**Intermediate**	**High**	**Very high**
Quantity (m^2)	941,9	358,8	31	7	2,5
Percentage (%)	70,24	26,76	2,31	0,52	0,19
Landcover	Forest	Forest	Agriculture-Forest	Agriculture-Settlement	Agriculture-Settlement

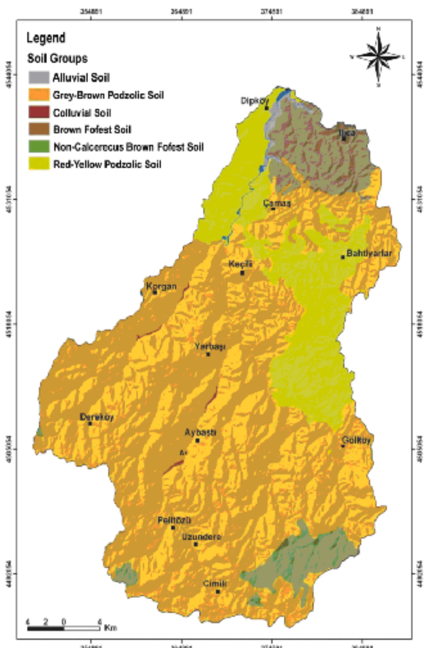

Figure 2: Soil classifications of the basin.

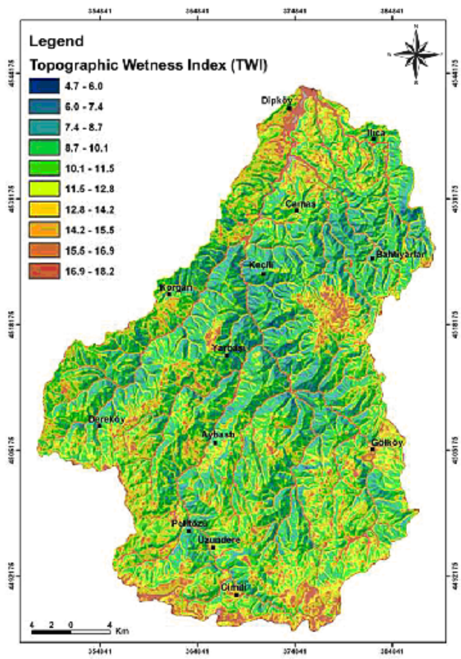

Figure 3: TWI classification of the basin.

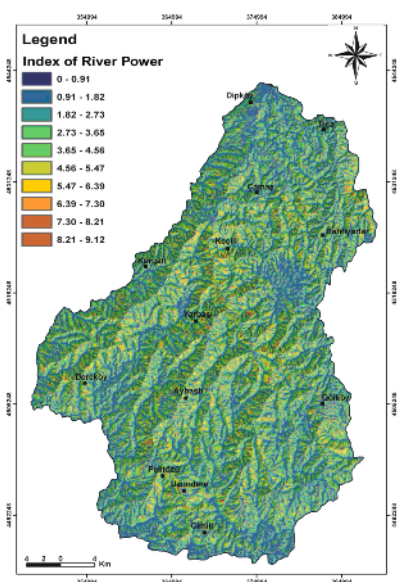

Figure 4: SPI classifications of the basin.

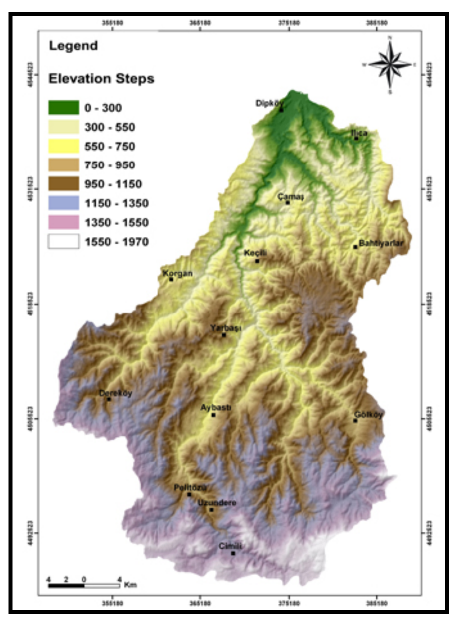

Figure 5: Height classifications of the basin.

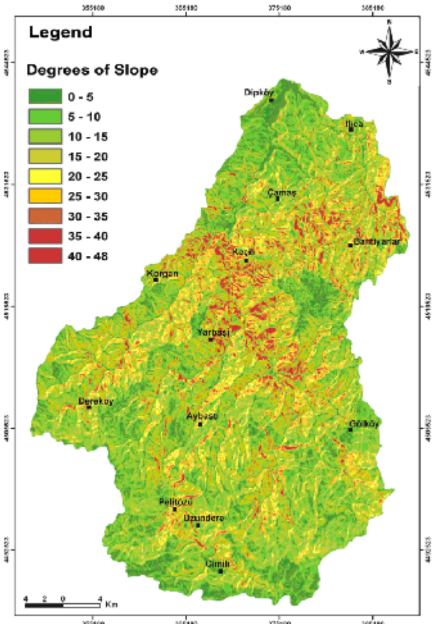

Figure 6: Slope classifications of the basin.

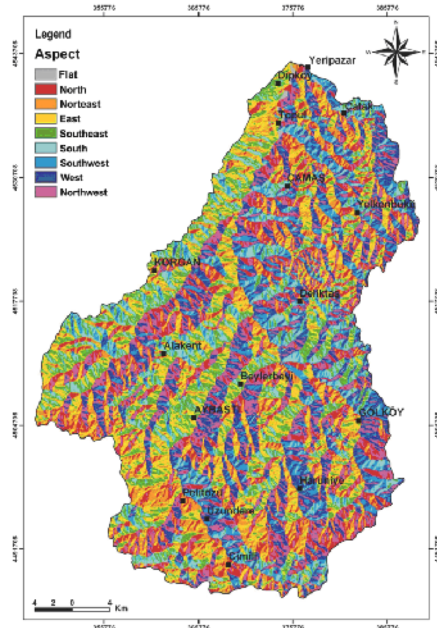

Figure 7: Aspect classifications of the basin.

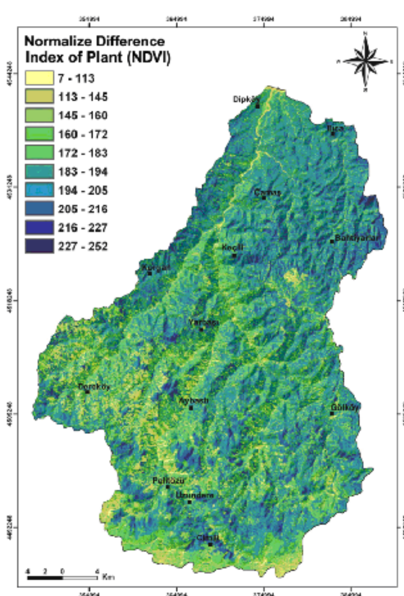

Figure 8: NDVI classifications of the basin.

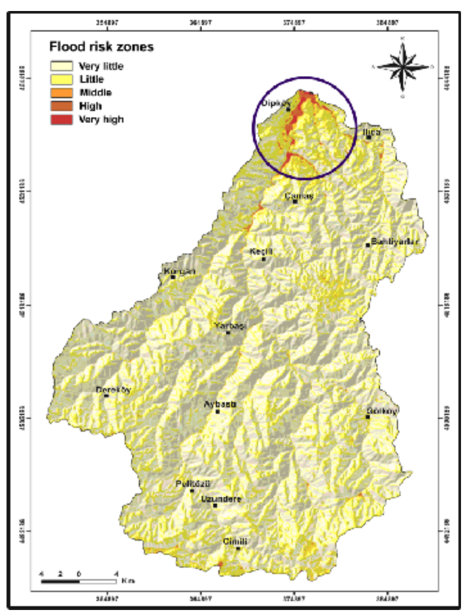

Figure 9: Flood risk zones of the study area.

ECOLOGİCAL İMPACTS OF FLOODS İN THE BOLAMAN RİVER BASİN

Floods affect on ecological environment both directly and indirectly and in changing degrees. Besides, these effects of flood differ according to flood zones and cause not only natural resource losses but also environmental degradation. Apart from flood damage, increased development in the floodplains has negative environmental effects, such as water and soil pollution, destruction of agricultural land and wipe of natural flora and fauna (BİRKLAND et al. 2003, NYARKO 2000). These developments took place in the Bolaman River basin during each flood disaster, exhibiting an increase year by year.

Dominated landcover typies in floodplain and lowlands near the Blacksea coast are urban and agricultural areas (Fig. 10). During the flood, large amount of water distribute to these parts of basin occupied by urbanization and agricultural activities. Both damaging impact of water and accumulation effect of inundation create a huge degredational environmental change in these parts of Bolaman River. Flood sediments accumulate on agricultural land and cause deterioration of fertile soils.

Additionally, during the flood disaster, large amount of water inundates the settlements and destroys the buildings, substructures of urban, chemical, paint and agricultural drug industry in floodplain of the Bolaman River. These impacts of flood cause the water and soil pollution. Water and soil pollution caused by flood disaster triggers the ecological environmental problems indirectly. Direct and indirect negative effects of inundation in Bolaman River are seen after every flood, and continue for a long time in a changing severity.

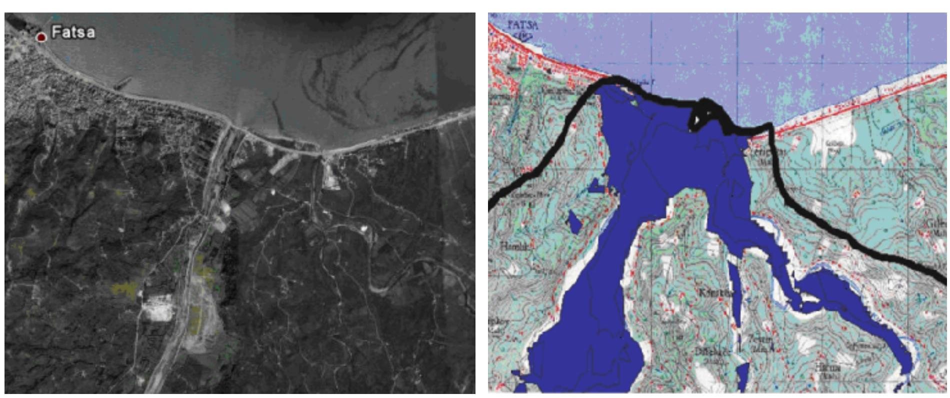

Figure 10: Landcover features and flood area in stream down of Bolaman river.

RESULTS AND DISCUSSIONS

In this study, inundation zones in Bolaman River basin were determined by means of flood risk analysis. When results overlapped landcover data, it was seen that flood areas occupy on urban and agricultural areas completely. This situation causes degredational ecological environmental problems and natural resource losses. Agricultural areas in inundation zones are under the threat of spoil. Other areas under the inundation threat are urbanization lands. The floods occuring every year are not coincidence but they are the natural results of physical circumstances and human activities. Results of GIS analysis inference that the floods will occur in the future in Bolaman River basin. Taking this fact into account, in the planning of inundation lands, flood zones should be determined.

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