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The Use of Satellites Images to Assess Flood Risks in Annaba (Algeria)

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Abstract: The anarchical urbanization makes some constructed districts on a plate down. Dwellings have been built on a part of the hydrographical network. Every year the flood causes important damages. In order to protect the city against the flooding several amenities have been done, without taking into account the different leading plans of urbanism. These projects have presented a negative impact. The outflows network crossing the city and flowing in the sea underwent important changes. It pours a great quantity of water, in rainy periods, causing important floods. The floods approach analysis was made by privileging the contribution of the remote sensing and the GIS, as well as modeling to lead to the Mapping of the flooding risk areas around the town of Annaba and charts generation of land cover starting from the satellite imagery. The study of the fields of flood implies the knowledge of the space variability of the physical characteristics of the catchment on which depends directly the hydrological behavior. Such maps could be used in an operational context to identify areas at risk to their urbanization and to predict the impact of exceptional floods for different management plans of the sewerage.

Keys word: Remote sensing • GIS • Inundation

INTRODUCTION

In spite of fundamental progress accomplished in the comprehension of seepage path, by the design of hydrological models, even the most sophisticated, we cannot predict with confidence the phenomena related to the hydrological events in particular the floods (Fortin, 2001). The floods problem is a set of themes which is accentuated on the level of the policies on a worldwide; so quantitative evaluations of risks indicators are requested from all the levels. In order to fill with the deficiency of the traditional approaches, the use of the new tools for investigation is necessary (PIETRONIRO AND LECONTE, 2005). The remote sensing offers possibility to pursue the natural environment which allowed many applications in hydrology (Caloz and Puech, 1996); characterization of the occupation of the grounds and the covers vegetable, inventory of the water plan, extraction of DEM, the river network, etc. The remote sensing is particularly well adapted to the problems of integrated development of the catchment and the cartography of the fields of flood. The georeferencing statement of all the "hydraulic objects" contributes to define an exhaustive and detailed panorama of the episode flooding, expression of the realization of the risk.

The paper we present returns in a project total "Management of the natural disasters by remote sensing and SIG" of the town of Annaba" An applied phase has been carried out on the catchment area of Oued Forcha, the whole topographical, satellite and exogenic data, were analyzed, treated, piled up in the form of layers of independent information in raster mode. These criteria were combined and crossed in the SIG. Such a tool has made the analysis approach of floods possible by privileging the contribution of the remote sensing to chart the floodplains around the town of Annaba. Such charts could be used in an operational context in visualizing the potentially easily flooded zones at the risk, in order to envisage the impact of the exceptional risings and that according to the various plans of management of the sewer system and urbanization.

Mythological Approach

Geographical Location: The city of Annaba, located at North east of Algeria, being in plain, the rain water comes from several basins slopes. The figure1 watch the specificity of the site of the city compared to the basins slopes from where it is subjected to all the rain water which streams of the Mount of the EDOUGH (Figure 1).

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Fig. 1: Situation Annaba and catchments

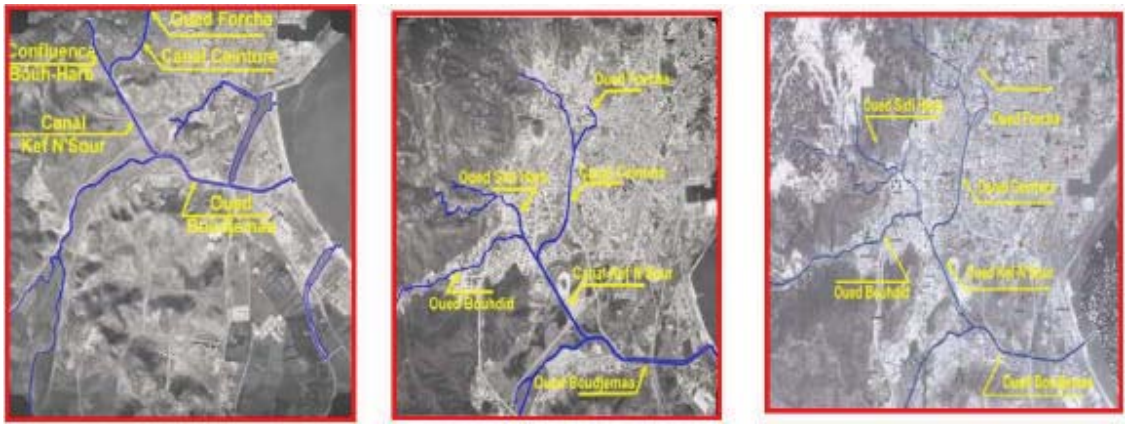

Fig. 2: Aerial photo of Annaba (a. 1972, b. 1992, c. 2005) 1972: rate of occupation along the stream is none. (Figure.2a) 1992: important urbanization rate and occupation of different sections of the river and embankment of several brooks.(Figure2 b) 2005: densification of urbanized zones and streambed invasion. (Figure 2c)

As a whole, the mountainous slopes turned towards the city are dominated by a forest of chaparral and Mediterranean undergrowth which extends on important area. These basins of the mountainous chain of the EDOUGH are heterogeneous. The hydrographic network, directed west towards the east, runs out through urban, rural and peri-urban areas. It pours a great quantity of water, in rainy periods, causing important floods. The phenomenon of the floods is accentuated by watersheds changes, which modified their characteristics acting on lows conditions. These changes are due to the uncontrolled urbanization and wild deforestation leading to a change and a modification in the environment and the type of soil occupation, embankment and derivation of different watercourses, occupation of floodplains of watercourses, modification of seepage path of rainfall runoff, the concrete lining of watercourses which accelerates the flows (Figure 2).

Study Zone: The choice of sub-basin Oued Forcha is guided by the availability of data (images, charts, hydrology, etc….) and of hydrological specificities as well as its increased and anarchistic urbanization. It has a surface of 711 ha and drained mainly by the "Ruisseau d'or" channel, treated in concreted channel of trapezoidal form. Its principal affluent is Oued Forcha with its various reach's.

are: __Topographic data: our zone of study is covered by a mosaic of five topographic charts covering the whole area on a 1/25000ème scale __An image Landsat ETM+ of February 12th, 2004 __Air Photographs, 1972,1992 and 2005 __Results of simulations dedicated to the event of 13/12/2005 (Figure 3) hydrological of the BV by HEC-HMS (D*jedaoune and Sekhakhfa, 2006)*, river network by HEC-RAS *(HEBCHA, 2009)*. __Pluviometrical data of the area __Real Measurements (in situ)

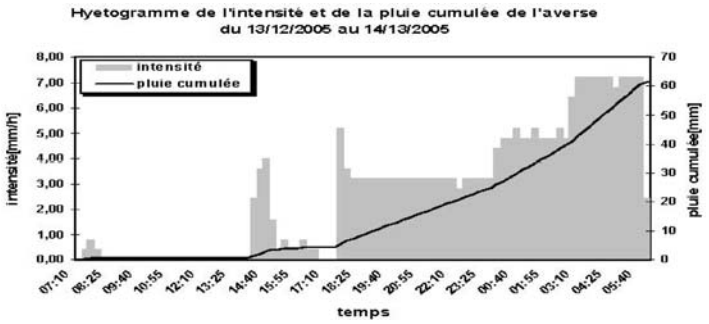

Fig. 3: Sudden shower Hyetogramme (2005)

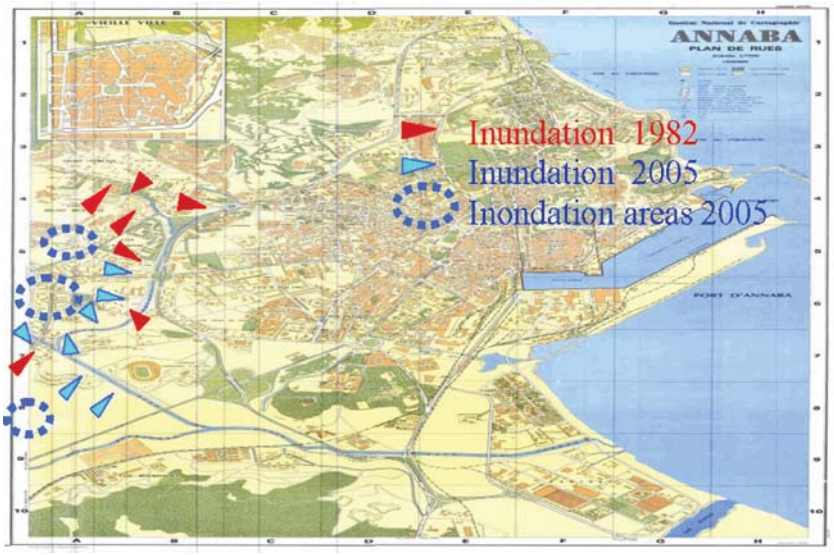

Fig. 4: Displacements of overflow points

During main events 1982-2005 we note that the rivers overflow points moved toward the downstream (Figure 4). It is a consequence of the protection's scheme implemented locally without any survey of the impact on the downstream. The undertaken upstream protections lead to a vulnerability at the downstream. In fact, there was no treatment for the problem in general. (SEKHAKHAFA, DJEDAOUNE, 2006)

Data Processing Sequence: Data processing sequence retained to lead to the cartography of the zones are of risks to the flood passes by stages of treatments and control; their logical succession is schematized in the following flow chart: Charts are setting by tool ARCGIS 9.1 in the system (UTM 32 Datum WGS 84), which representing the system of projection of Landsat ETM+ image, by using easily locatable points, identifiable and distributed in a homogeneous way on all the topographic chart. Software ENVI version 4.2 enabled us to carry out some treatments on the image. Many tools of analysis and image processing are included in the transformation of data, classification, geometrical and atmospheric corrections, (STRAHLER. 1980; KORNBLAU et CIPRA. 1985; GIRARD ET AL. 1989; ESCADAFAL. 1992; SHARMAN et al.1991, CHAO YONGCHALERMCHAI. 1993; MOSTEPHAOUI. 1997 UNIGE. 2001)

Tools for Spectral Analyzes: Setting of the charts and generation of the MNT UTM clarck coordinates projection 1880 "fuseau" 32 are transformed to projection UTM of ellipsoid WGS84 "fuseau" 32 (projection of image ETM+). The level lines, equidistant of 10m, are digitized (Figure 6). (KETTAL 1996, JENSON and DOMINIGUES 1988).

River Network: Techniques of network extraction starting from DEM raster are based on the geomorphological analysis by local characterization of the altimetric variations and the follow-up of the flows (Charleux-Demargne Julie, 2001, RIAZANOFF 1989).

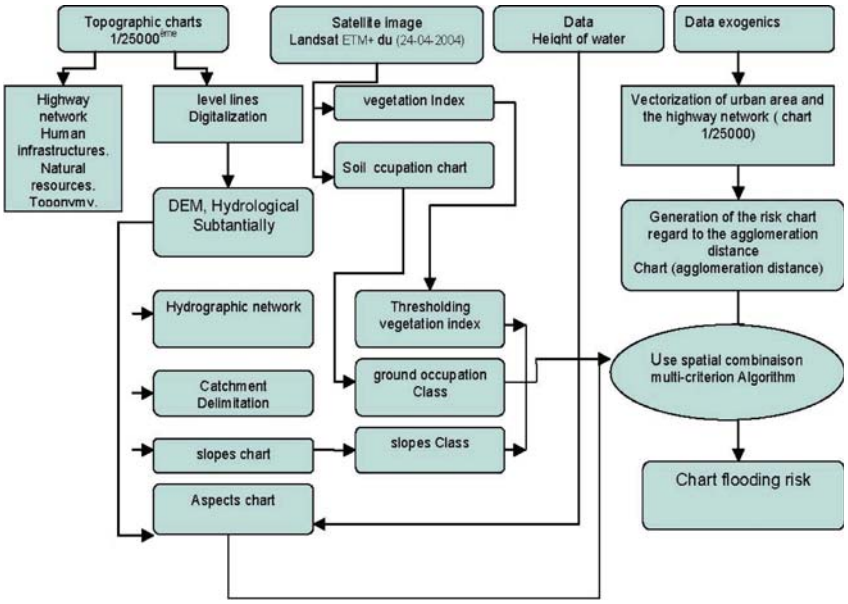

Fig. 5:

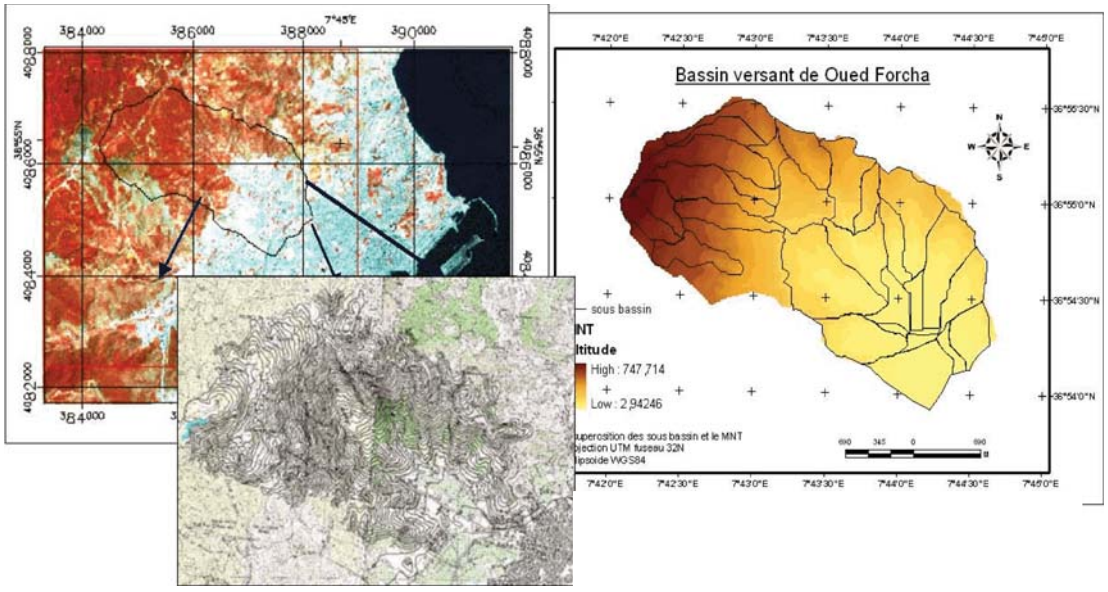

Fig. 6: MNT et limite des sous bassin versant Oued Forcha

Fig. 8: Directions des ecoulements

Fig. 9: Accumulation des eaux

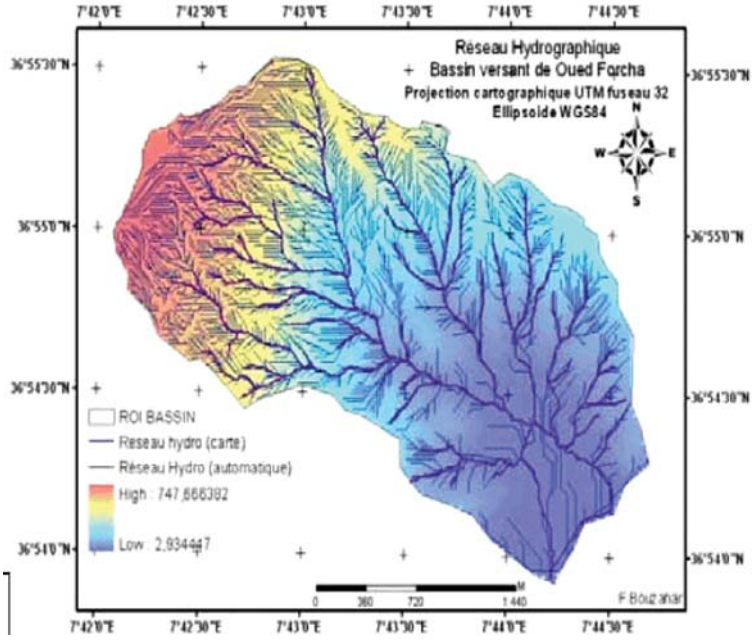

Fig. 10: Superposition des reseaux hydrographiques

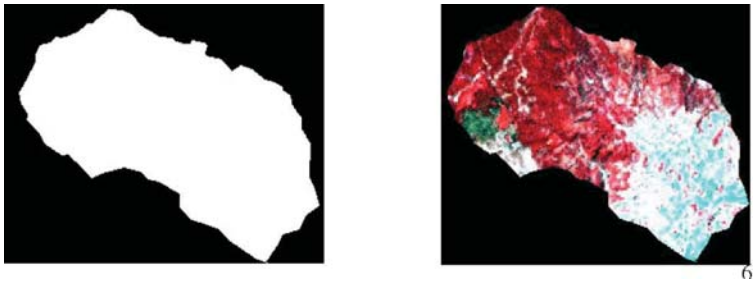

Fig. 11:

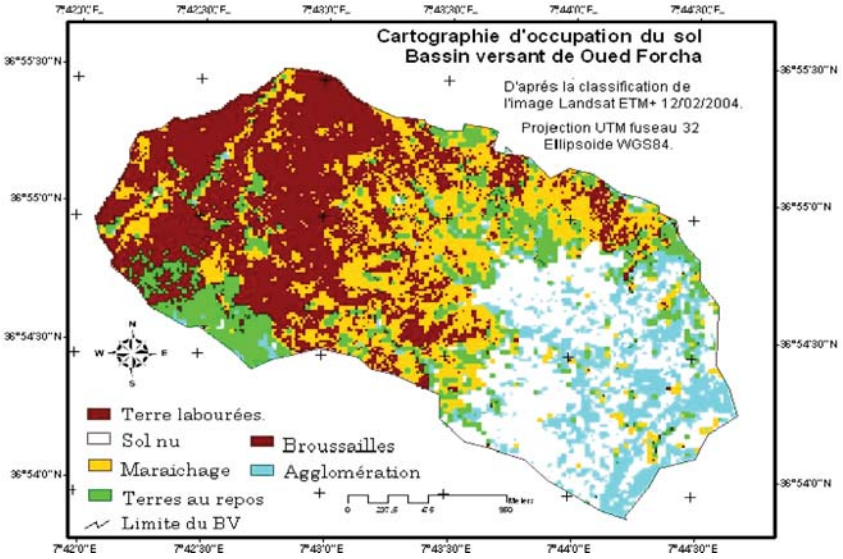

Fig. 12: Soil occupation-classification

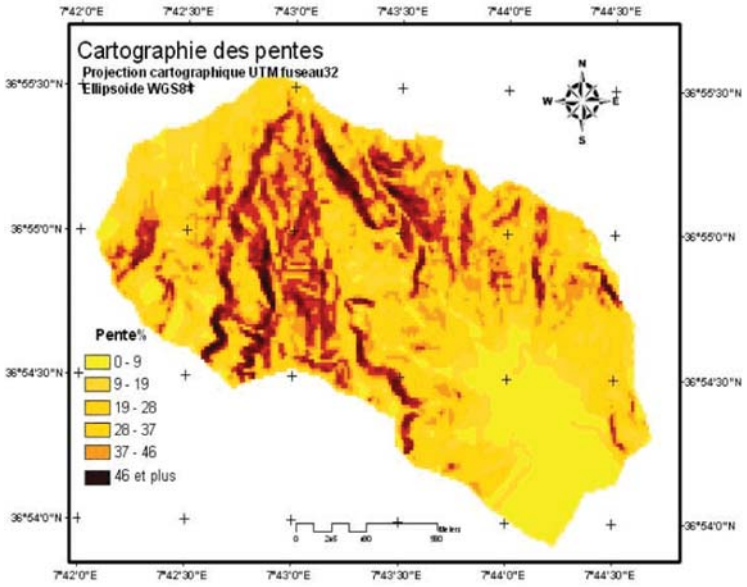

Fig. 13: Slop cartography

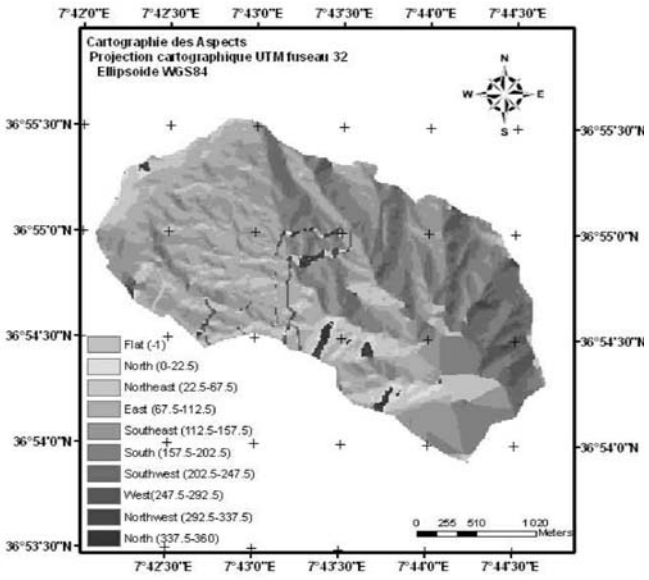

Fig. 14: Aspects cartography

After setting of the water directions chart (Figure 8) and chart of accumulation (Figure 9), the river network is extracted starting from the MNT (D8 method). Figure 10 shows superposition of the extracted network river and the network extracted manually who are practically confused in planimetry and a good precision in altimetry.

Soil Occupation: The multi spectral image ETM+ 14,25 m (Figure 10 and 11) is classified in several topics. Seven classes (Figure12) are identified. The class's agglomerations soil represents the lowest part near the supporting discharge system of the problems of flood considering their very low permeability. The other classes represented by the plowed grounds, the grounds at rest, truck farming and undergrowth which is surfaces more where less permeable present a less important risk of flood (Figure12). The matrix of confusion shows that the percentage of classified good is of 99.47%. We classified the image multi spectral ETM+, resolution 14,25 m (Figure 10 and 11), in several topics and identified seven

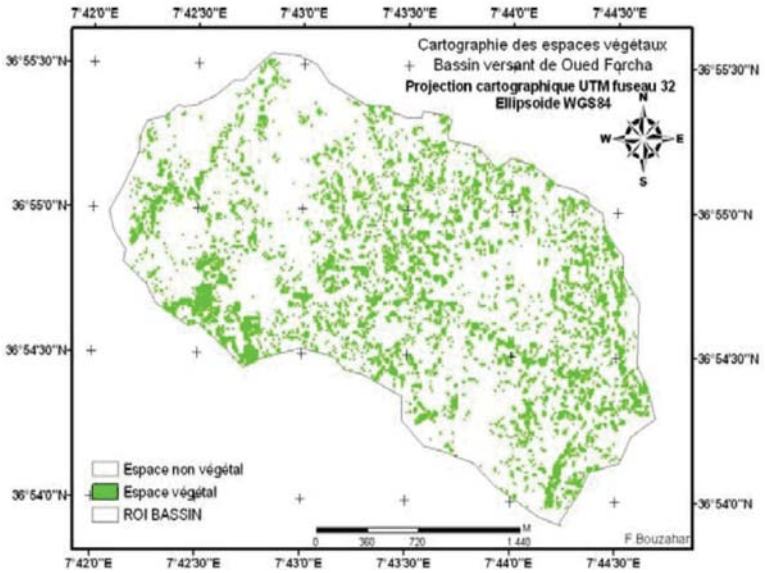

Fig. 15: Vegetation Classification

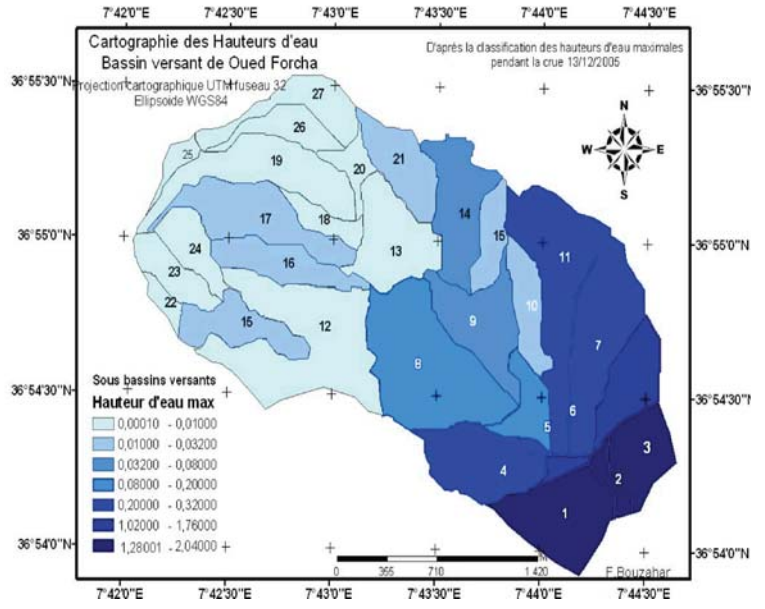

Fig. 16: Water heights

classes (Figure12), the classes agglomerations and soil ground represents the lowest zone near the outlet. The other class represented by the plowed grounds, not plowed ground, truck farming and undergrowth which is area more where less permeable. (Figure12). The matrix of confusion shows that the percentage of good classified is of 99.47%.

Slopes and the Aspects Cartography: The slope is a parameter of prime necessity which intervenes in the hydrological determination of many indices. The quality of the slopes chart is very important. It is used to analyze a catchment correctly (Figure 13). For surface hydrology, to determine the chart of the aspects amounts determining the chart of the flows (Figure 14)

Vegetable Spaces: The chart hereafter represents the classification of index *NDVI (=(infra-red-red)/(will infra red +red))* carried out under ENVI generated starting from the Landsat image of the 4/24/2004. (GDTA. 1993) (Figure 15) 8-Chart water heights Data used to generate the chart heights are the results of hydrologic simulation

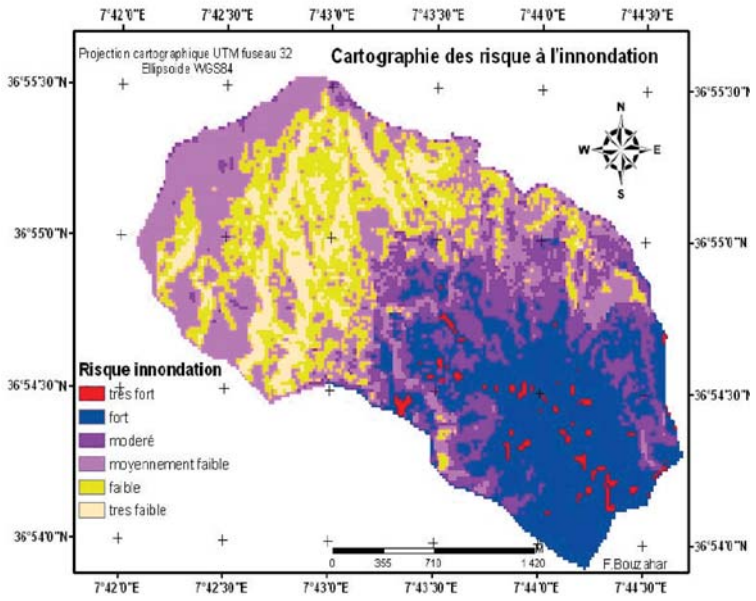

Fig. 17:

Figure 18 – image Quickbird

Figure 19 – inundation Oued Forcha (2005)

Fig. 20: Inundation Oued Forcha (2009)

of the BV of annaba by HEC-HMS (SEKHEKHFA and DJDAOUNE,2006), giving values of the streaming and the hydraulic results of the simulation of river network by HEC-RAS (HEBCHA, 2009) and the values measured on ground. Classification was carried out under Arcgis on the basis of height of water. The resulting chart (Figure16) is an indication on the zones that are likely to be damaged.

Inundation Risk Cartography: The risk chart is obtained (figure 17) by the techniques of spatial analyzes of the ArcGiS. They resemble in their principle at the multi-criterion algorithms. It expresses the risk of damage due to the floods. The use of a multi-criterion approach allows the spatial prediction multiple superficial movements to result in cartography thematic sets reliable. (Mulders 2001). The risk of damage weak, average, high is resulting from the combination of the flooding risk and the vulnerability.

The extraction of the class, risk very extremely (color in red), starting from our chart risks flood and its superposition on an image with very high resolution spatial (Quickbird; 0.60 m), is in conformity with field realities (figure 18, 19 and 20).

CONCLUSIONS

The development of these various approaches of division space was partly carried out due to the SIG that makes it possible for the testing of several methods of analysis space. Indeed, the SIG experienced a considerable development during the ten last years in term of technology, method of analysis and coupling with hydrological models. They became tools that are impossible to circumvent to define and characterize the space units of the model. A discussion on the contribution of the SIG in the context of hydrological modeling was carried out by Payraudeau (2002). The study presented belongs to a general investigation in progress, on the area of Annaba. The obtained results for Oued Forcha seem very satisfactory and are in total agreement with reality.

REFERENCES

2. Pietroniro and Leconte, 2005. A review of Canadian remote sensing and hydrology, 1999-2003, Hydrol. Process, 19: 285-301.
6. Kornblau et Cipra, 1985. Analyse spatiale et mise en place de systèmes d'information pour l'évaluation de la vulnérabilité des territoires de montagne face aux risques naturels, Thèse de doctorat, spécialité Géographie, Univertsité J. Fourier, Cemagref.
9. Sharman, *et al*., 1991. Action IV, de l'image aux statistiques: Bilan opérationnel après deux années d'estimation rapides des superficies et des rendements potentiels au niveau européen. Rapport concernant le projet pilote pour l'application de la télédétection aux statistiques agricoles, ISPRA.
11. Mostephaoui, T., 1997. • Utilisation de la télédétection dans la cartographie des sols et dans l'évaluation des _asin_ialities agricoles en vue d'un aménagement Hydro-agricole à l'aide du S.I.G •, cas de la plaine de Berriche et du _asin versant de l'Oued Guerrah (W. d'Oum El Bouaghi). Thèse de magister. CNTS, Arzew., pp: 144.
13. Kettal, 1996. Système expert d'information géographique orienté objet Application a l'écoulement de l'eau sur les terrains. Thèse Institut national des sciences appliquées.
14. Jenson and Domingues, 1988. Extracting topographic structure from Digital Elevation data for geographic information system analysis. Photogrammetric Engineering and remote sensing, pp: 1593-1600.
16. Riazanoff, 1989. Extractions et analyse automatique de réseaux à partir des MNT, Contribution a l'analyse d'image de teledetection. Thèse université de paris vII, pp: 84.
17. GDTA., 1993. Les spatiocartes: méthodes et exemples de réalisation. Cahiers pédagogiques du Groupement pour le Développement de la Télédétection Aérospatiale.