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THE COASTAL PARALLEL FLOWS PATTERN IN THE BUSHEHR COASTS BY SOFTWARE MIKE21 WITH PROPOSING MODEL HD

NAZANIN MOHAMMADISAVEH

Physical Oceanography, Islamic Azad University, North Tehran Branch

***Corresponding Author: E Mail:nazaninas2006@yahoo.com**

ABSTRACT

Bushehr coasts are the most important fishing and commercial areas in the south of Iran. These coasts are ended to Khuzestan province from north and some part of Kohkiluyieh and Boyier Ahmad and from south ended to Persian Gulf and some part of Hurmozgan province and from east and north east ended to Far province and form west and south to Persian Gulf. Coastal flows can be formed affected by different factors. Determining the flow pattern is the primary step for research and identification of the effective factors on the flow behaviors and conditions in the coast. In other words, related to identification of the effective factors on marine environments and coastal areas, determination of the coastal patterns and the waves is very important since the coastal flows play an important role in determining the coast geography and shape. The costal flows are shaped due to breaking waves, wind flow and sea level difference and the concurrent effect of wind and wave. Of these costal flows it can be referred to flow parallel to coast, flows vertical on the coast and return flows. Parallel flows move parallel to coastal line. The main cause of these flows is breaking wave and wind effect. MIKE 21 modeling system has separated modules, in this research wind, wave and bed data in the Bushehr ports district are used and by the help of HD module the radiation stresses components are calculated and by these components the effect of wave on these flows is investigated. A costal parallel flow in total modeling period was identified that continues from northwest to southeast. Since time of modeling until 30 hours later it seems that the flow velocity is approximately constant and always it is less than 0.5 m/s,

after 30th hour until end of the flows period the flow velocities are reduced along the coast and near to coastal line gradually.

Keywords: Parallel Flows, Coast, Bushehr Coast, MIKE 21 Software, HD Model

INTRODUCTION

Persian gulf is a region of India ocean, it is connected to the Gulf of Oman and in the east by the Strait of Hormuz, Economically in about 60% of marine oil trade in the world is doing through this Strait and ships transportations are a lot in this stairs and almost every 6 minutes, a ship passes through this strait.

The Persian Gulf depth in near of offshore is to 20 meters and 40 meters in the central regions. Around the Kish and Lavan islands, gulf is deeper and in some areas depth is 80 meter. But the minimum depth in the Strait of Hormuz is about to 100 meters. Depth is very high in the other region of the Strait of Hormuz in Oman ocean (Sevini,1383). Christian and Kani (CD christain & PA Coney 2001), were considered flows caused by tidal flows, wind and waves in the Gulf of Harky (Haurki),stimulate by using of MIKE 21, and the networks points distance and the time step were 1000 meter and 120 second, respectively and and the network utilized was 131'82. In this study, we used region wind pattern (wind rose).Ghazi Dezfuli and Karami (1386) had studied flow pattern at the entrance of the Kiashahr lagoon and for this purpose, alongshore flows pattern in both states, before and after the construction of jeti were stimulated by using of mathematical models of Mike 21 and they were analyzed the effect of this structure on alongshore flows pattern. Although the use of this model is common to calculate of flow but in this study is considered to phenomena's such as changes in flow patterns in the estuary, rotational flows and their effects on erosion and sedimentation in the estuary. Also, two types of tidal and non-tidal estuaries were studied in this project for more studies. Daghigh and Karami studied the effect of different heights on the coastal morphology and the effect of the jeti construction on flow and sediment transport models by using of numerical model of MIKE 21 in Bandar-E Kiashahr area. General flows pattern is same in before and after of jeti construction in different directions. Flow rates is less in eastern part of port entrance. North and north-west wave flows have a flow as flows of back to the sea with hitting to western arm of the jeti. Allah Dadi and Kolah doozan(1381) were studied numerical modeling of tidal flows in the Bushehr Gulf.

Allah Dadi and his colleagues(1380) studied Wave analyzing b using of Mike 21 numerical models and field measuring in the Persian Gulf and the place of Khor mousa. In this study, the network points distance was considered 60 km in X and Y directions. Numerical simulation and measurement were doing during two months (August and October 2000) and it showed a near relationship in calculated and measured values. Fallah and his colleagues(1383) studied evaluation of WAM and MIKE 21 NSW mathematical models in stimulation of Khazar lake. In this study, all of the information, including basin hydrographic and wind data are defined the same in both models. Finally, It is concluded that the highest waves in both models and results of the ships observation occur at the same time by drawing main wave height in different seasons and to compare them with wave data of wind recorded on the ships. Although, sometimes will be seen differences between the results of models and the results of the ships observation. Some models have been proposed by some researchers in modeling for parallel coast flows that we refer to them.

1. First model: The model was presented by Mr. John Casey and Edward Tharnton that this model used for flat beaches and in this model it is assumed that air pressure and sea level pressure are balanced. This model is consistent with experimental observations.
2. Second model: This model was presented by Mr. Shinichi Yanagishma, Yashimasa and Kuriyama and in this model was studied 15 years information of flows of water, wind and wave. it was found that due to the different wind and wave conditions, when the water flows spreading to north direction, wave height was low in offshore and wind frequency velocity to the south direction was similar with wind frequency velocity to north direction. As a result, the only one flow to near of coast was spread and it was disintegrated in outside of aquiferious narrow area.

On the other hand, when the water flow was spread to south direction and wave height and wind velocity were almost large in offshore and wind velocity was high to south direction that caused a flow in all of the aquiferious area (inside and outside of aquiferious area).After the correlation of these two models, a mean a velocity was obtained for alongshore flows that is calculated with a velocity near to north direction and a velocity to south in offshore.

3. The third model is NMLONG model that was developed by the US military research program. This model is measure to wave changes, water level changes and alongshore flows around a single view line assuming uniformity of coast in a view and hydrodynamic processes. NMLONG solve the wave equation for energy permanence and it presented wave accumulation and wave breaking and its reconstruct.

The study area

Bushehr Province is located along the coastal region on the Persian Gulf coast of southwestern Iran with coordinate of 27°14′N to 30°16′N and 50°06′E to 52°58′E and totally, it covers 2 degrees, 56 minutes longitude, and 3 degrees and 2 minutes latitude. This province with an area of about 28,000 square kilometers, is a long and narrow province that most of its area in dividing is located into natural coastal plains in southern Iran. Bushehr province with about 625 km is located along coastal strip in north of Persian Gulf. Bushehr nuclear power plant, refinery gas Fajr Jam and Gas Refinery and Petrochemical Assaluyeh plays a significant role for this province.Bushehr province is along the coastal strip, begining and the end of that is from Bandar-E Deylam (port of Deylam) to Nayband gulf(Khalij-E Nay band),respectively and it is one of the longest border of Persian Gulf. All of Bushehr coast gulfs have a nose and their shapes are not comparable with index gulfs and omega shape. Trade, fishing and shrimp and related industries such as boat building and net-weaving are the most important economic activities of residents of the coastal areas of Bushehr. Bushehr coasts is one of the strategic areas in term of military.

According to the classification system of Shepard, Bushehr province coasts classified into the following groups:

1. **First Coast**:

A: Coasts from land erosion: In this types of coasts, rocky coasts group can be seen like a narrow band in bushehr.

B: coast from sediments transported in land: In this types of coasts deltaic coast can be seen in areas of Mand, Hile and Darreh Gap. Coast of alluvial plain with alluvial fan can be seen in Gonaveh and Deylam regions. Wind deposits can be seen in Bord Khun region.

2. **Second Coasts:**

A: Non-regular coasts created by wave

B: Coasts from sea Sedimentation: In this group, there are smooth coasts by the waves, mud areas and coastal rocks in Bushehr province.

C: Coast created by the plants and animals: In this group, Mangrove forests, coast of marsh and man-made coast can be seen in this province. Coast of Bushehr province has not uniformity combination and form. This factor has caused a special conditions arise in different areas of Bushehr Province. The greater part of the coast in the province, especially from Bushehr city to the North West to the last northern border are in the form of sand or mud, smooth and rarely rocky.

Bushehr province is located completely in extratropical regions or the subtropical high pressure belt and lack of rainfall is the most important features in this area. In the, there are only two areas of dried and semi-dried climate in Bushehr regions. About 80 percent of Bushehr area in dried climate is located and covered in north to the southern and western pars and about 20 percent of province in semi- dried climate is covered as longitudinal strips along the border of Fars province. Because of factors such as low height from sea level, low altitudinal changes range, exposure to warm the Earth's sphere of influence belt (Tropic of Cancer) can be located completely Bushehr province in almost a dry area. In this study, bathymetry data of

Bushehr coast is used in the range of latitude and longitude following for modeling.

$$50.03518°E \le long \le 51.08040°E$$
$$28.54785°N \le lat \le 29.20400°N$$

METHODOLOGY

Waves, winds and tides data, and bathymetry data are need to modeling. Bathymetry data of the Persian Gulf in Bushehr coast was provided mapping organization, this data was converted into the software of Mike 21 (* .tfs2) and It was found in the land areas. Also wave and wind data were need to modeling of flows. For this purpose, wave and wind data were prepared from Ports and Maritime and Meteorological Organizations for a period of one year in 2002 year in the study areas and wind rose and wave rose of study area were drawn in 2002 year. Data obtained were used in the next stage.

Findings of study

Creating of input files to the software Mike 21

It is required that data converted to logical format to entry into software Mile21 to use bathymetry data and the data of wind, flows and tides.

The topography of the study area

In the first stage, the bathymetry data is converted to (*.dfs2) format to entry of software Mile21 that taken mapping organization and map of seabed topography were obtained in the study area (figure 1).

Wind and wave data

Wind and wave data relating to a period of one year (2002) for every six hours once had been collected that taken from Meteorological Organization and ports and navigation and all of them were converted to entry of software Mile21 in (*.dfs2) format. Data wave are including wave height index, peak frequency period of wave and mean wave direction. Wind data are including wind velocity and direction at a height of 10 meter. Also wind rose and wave rose of the study area were prepared for a period of one year (2002) (figures 2 and 3).

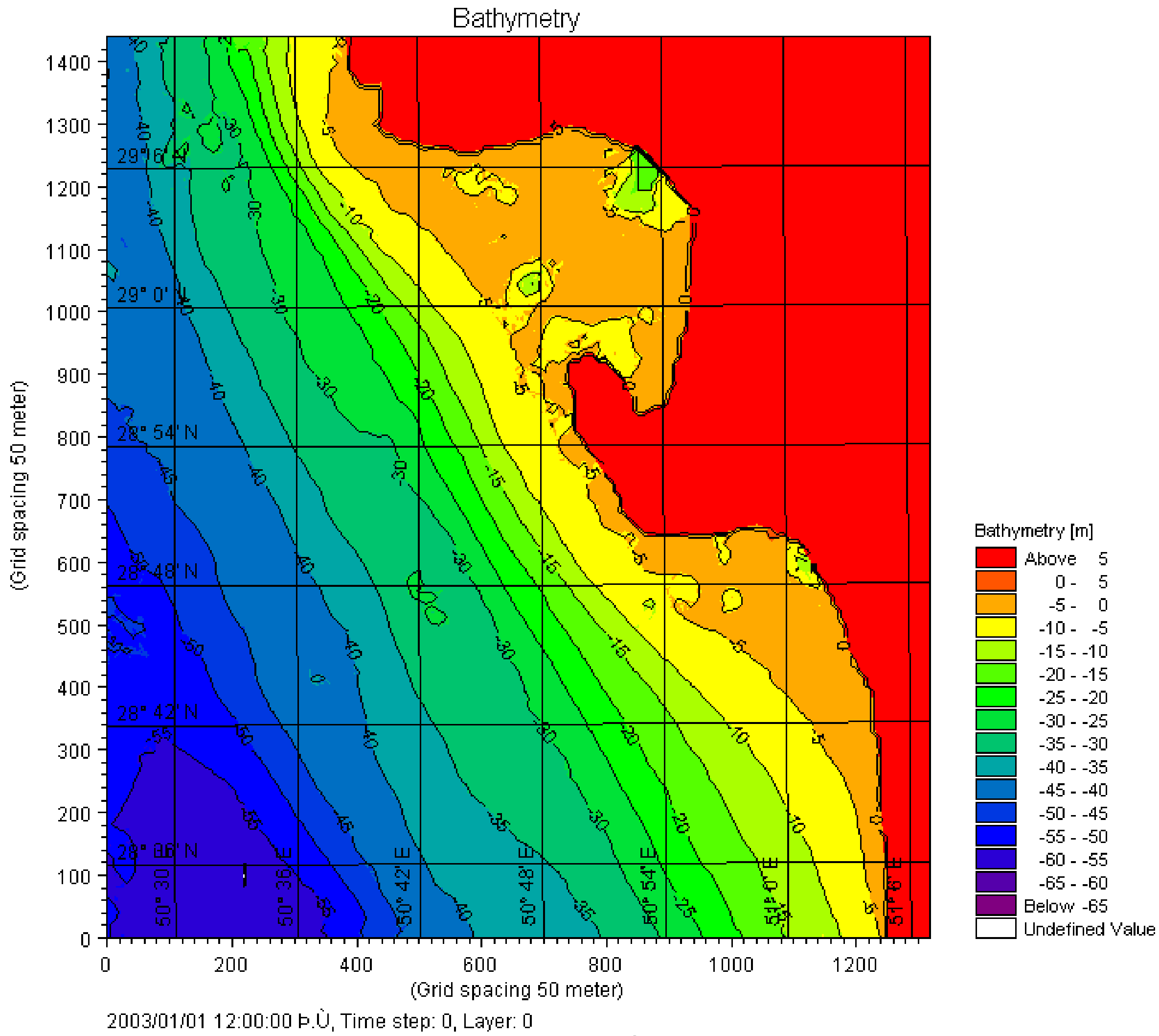


Figure 1: Topography of the study area

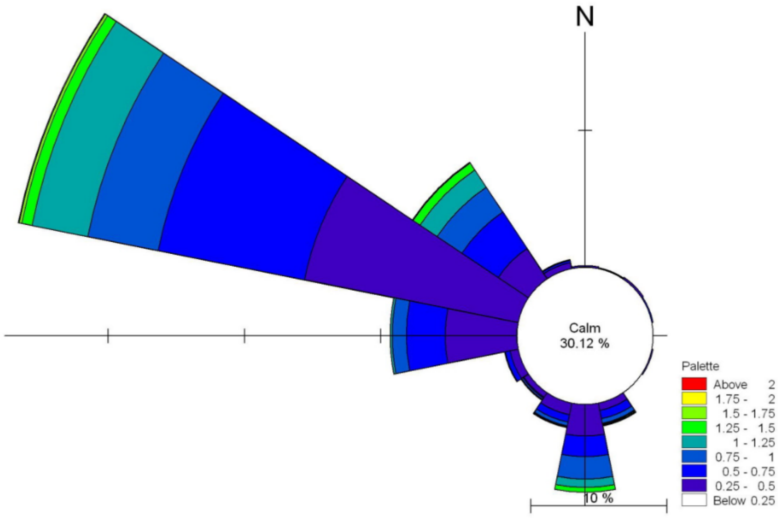


Figure 2. Wind rose of Bushehr coast related to 2002 year

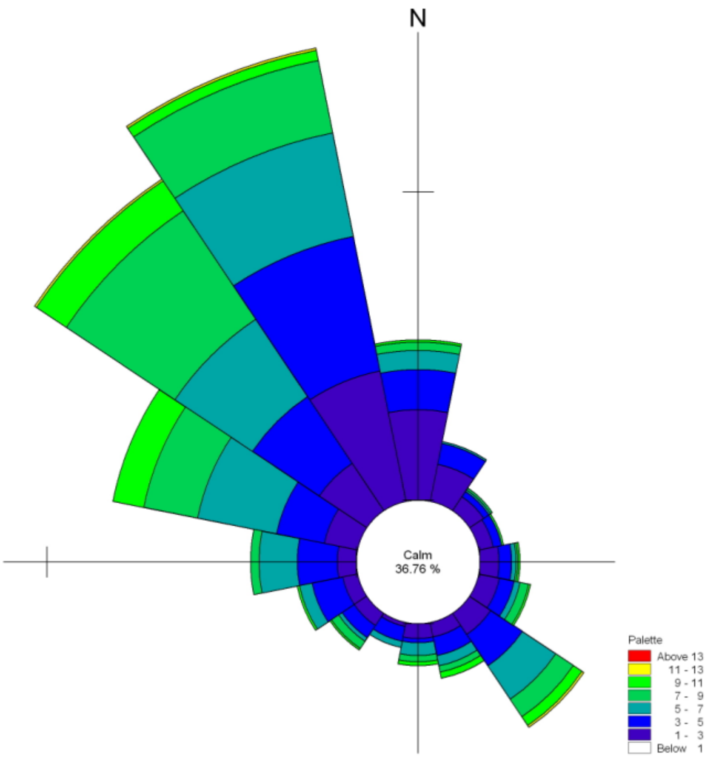


Figure 3: Wave rose of Bushehr coast related to 2002 year.

HD model

We were used Mike 21 Flow Model to study of flows in Bushehr coast. We consider only hydrodynamic mode in main parameters. We were used bathymetry data in * .dfs2 file format.

In all models that work with finite difference methods, stability and convergence of model depends on profile of specific parameters such as the time step and local step of model. In hydrodynamic model has been defined a number index to determine the stability conditions of model. This number is that Courant Number, in order to achieve full stability should be about 1. In cases where topography changes are not severe, with Courant numbers 5 and 6 can be reached optimum stability.

Courant number is calculated according to the following equation:

$$Cr = c\frac{\Delta t}{\Delta x} \quad \ldots\ldots..1$$

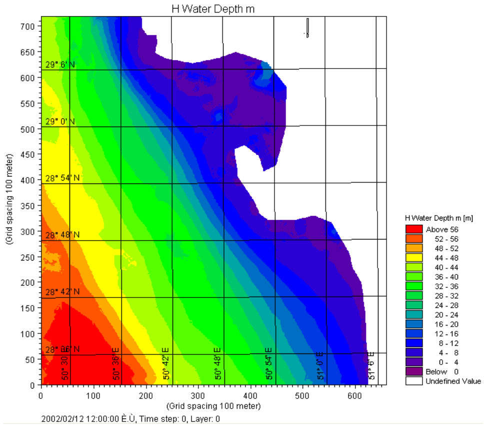
And

$$c = \sqrt{gh} \quad \ldots\ldots.2$$

Where g is gravity, h is water depth and Δt and Δx are time and local steps, respectively (Mike 21 guide, 2003).

In this research, implement HD model- 100 meter local step is obtained the maximum depth of 60 meters, so with time step of 10 seconds, Courant number of times is 5.2.Modeling was performed for a period of 48 hours. We used from wind and wave data for open borders means western and southern parts of model range that were collected for 6 hours. Manning Number of 30 was chosen for bed resistance.

Share of wave to the development of coastal flow was effected by using radiative tensions obtained from the NSW model. We are consider direction and prevailing velocities of wind as fixed for effect of wind. For this purpose, wave information considered to consist of velocity and direction were 6 meters per second and 315 degrees, respectively. The friction coefficient of the wind with the water level were a constant amount and equal to 0.0026. Outputs of model are consists of depth changes, level changes and flux and flow. Changes in water depth of the initial conditions of modeling, after a period of 24 or 48 hours is presented in Figure 4 and 5. Results of volumetric transmission as components P and Q (along x-axis and y-axis) is presented in figures 6 to 8 and results of water level changes flow velocity as component along the x-axis and y-axis (components U and V) and Taking mode is shown in Figures 9 and 16.



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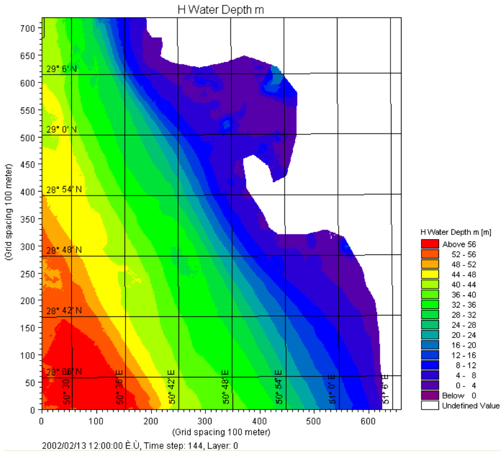

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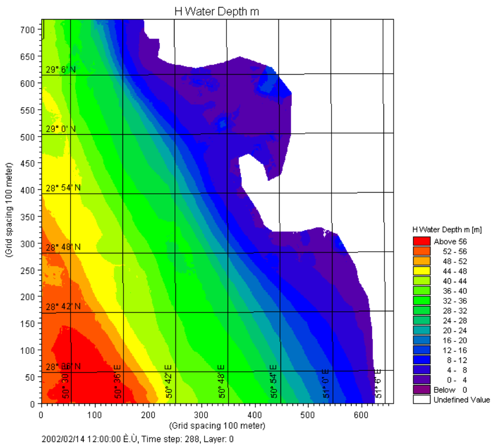

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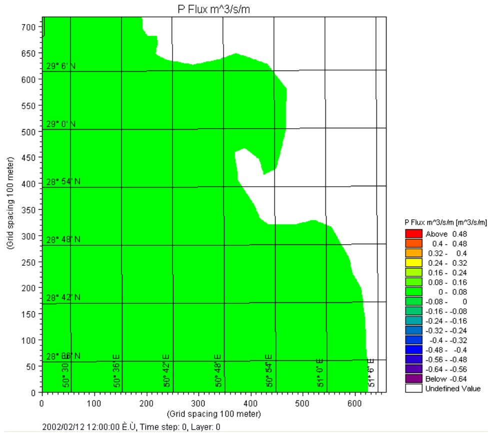
Figure 4: depth changed in the study area, a) at the start of modeling, and b) after 24 hours, and c) after 48 hours.



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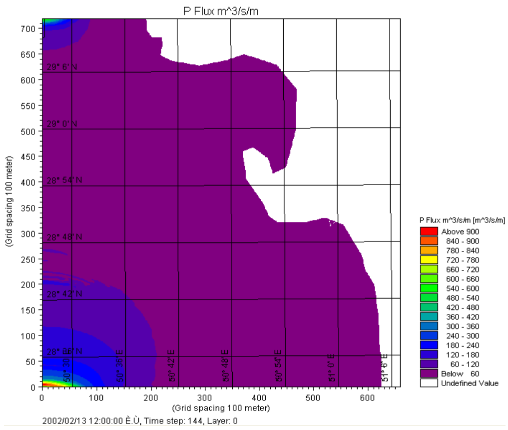

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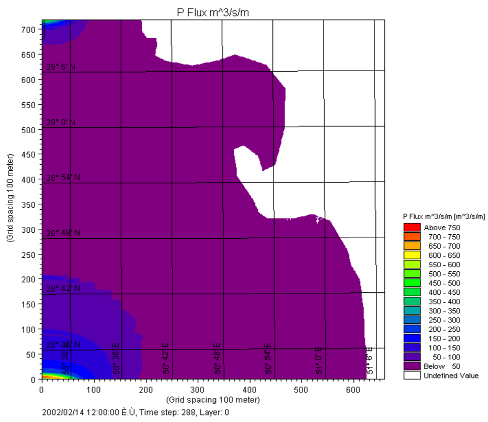

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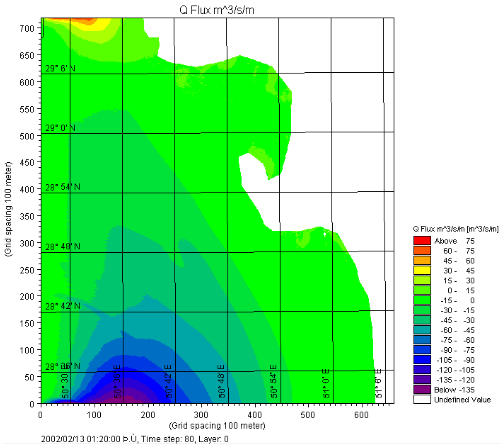
Figure 5 component of transfer of water volumetric mass in direction of x- axis, a) at the start of modeling, and b) after 24 hours, and c) after 48 hours.



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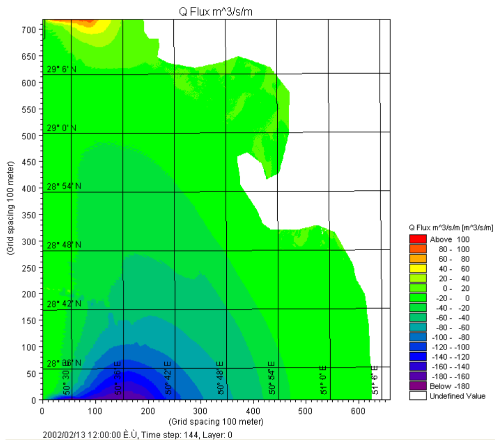

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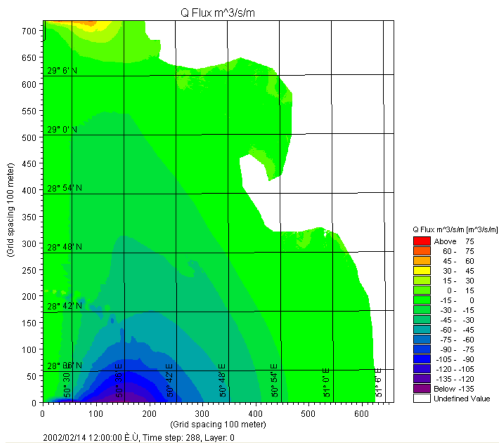

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Figure 6 volumetric mass transmission component of water in direction of y-axis, A) at the start of modeling, and B) after 24 hours, and C) after 48 hours

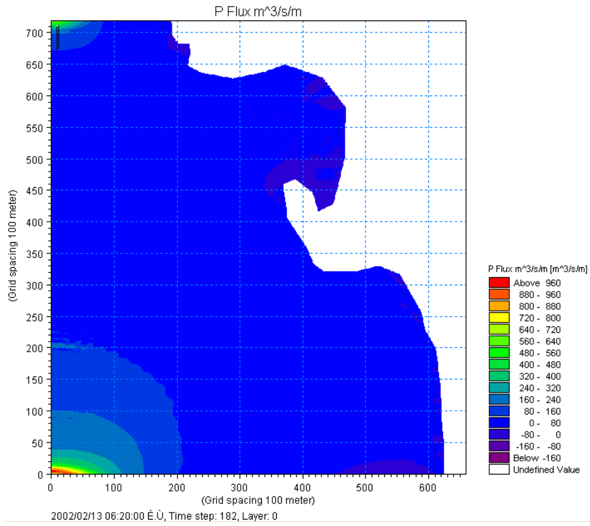


Figure 7 .Pattern of volumetric transmission component maximum ($m^3/S/m$) along the x –axis

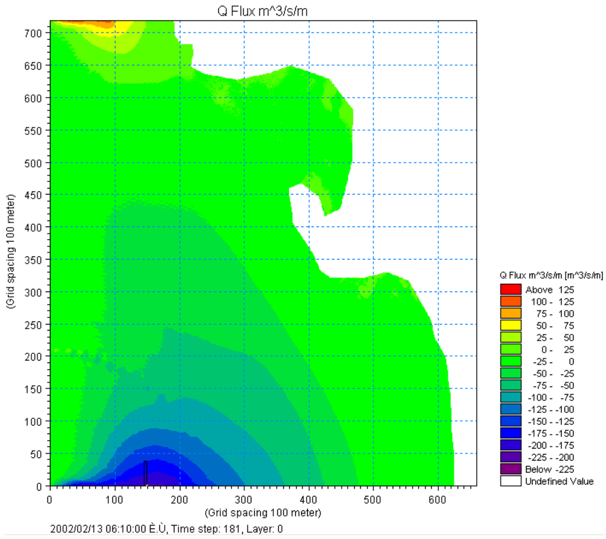
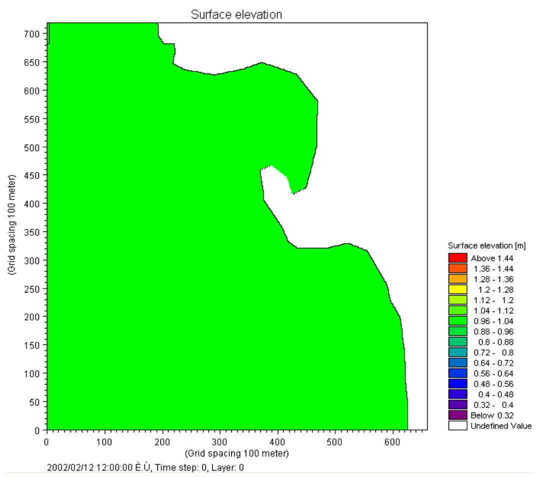


Figure 8 .Pattern of volumetric transmission component maximum ($m^3/S/m$) along the y –axis



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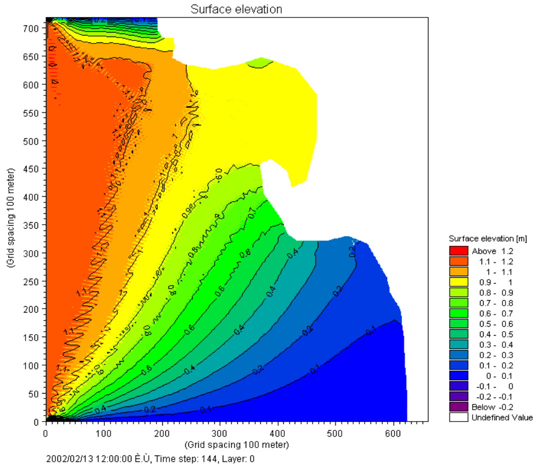

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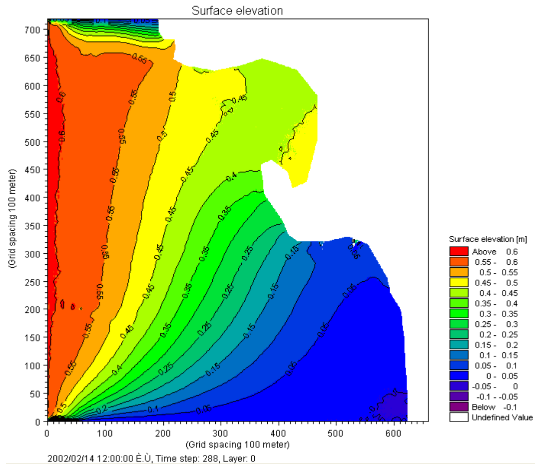

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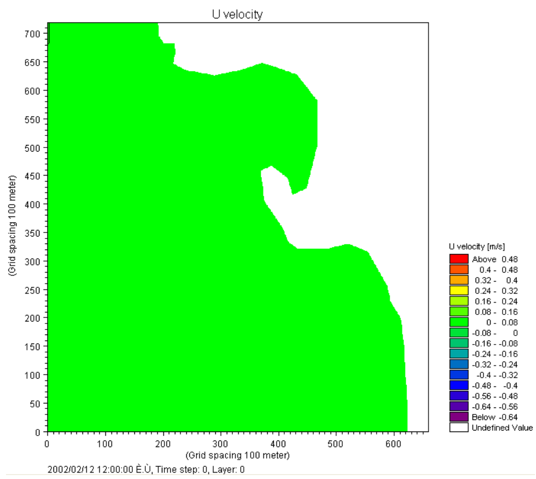
Figure 9. Water level, A) at the start of modeling, and B) after 24 hours, and C) after 48 hours



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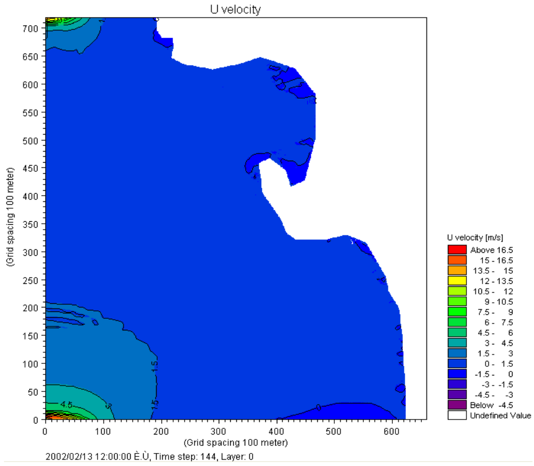

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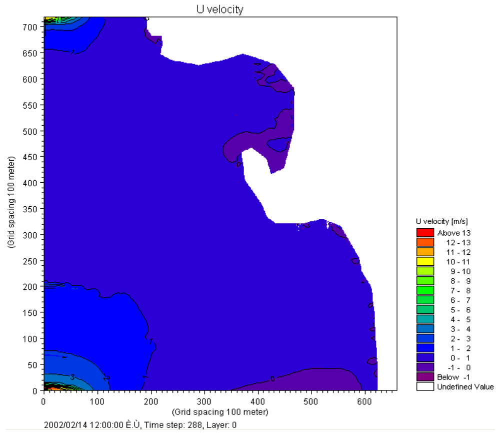

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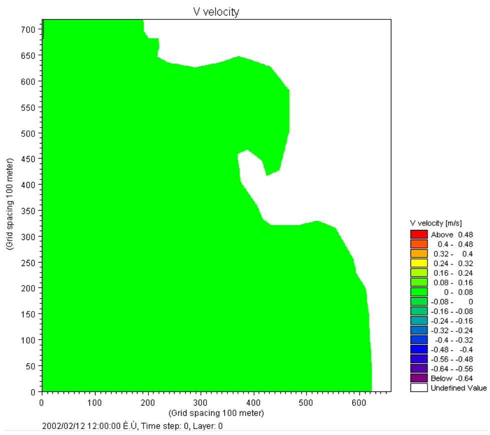
Figure 10: Flow velocity component along the x-axis, A) at the start of modeling, and B) after 24 hours, and C) after 48 hours



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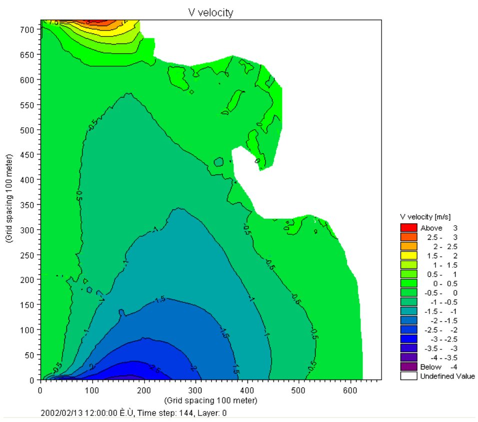

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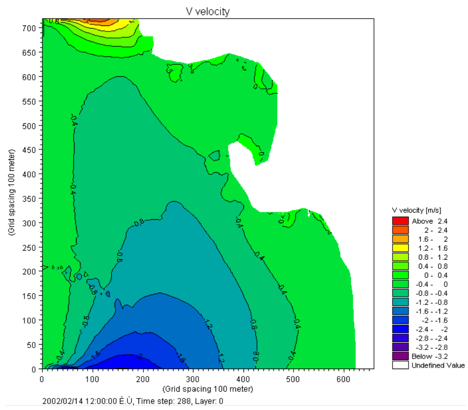

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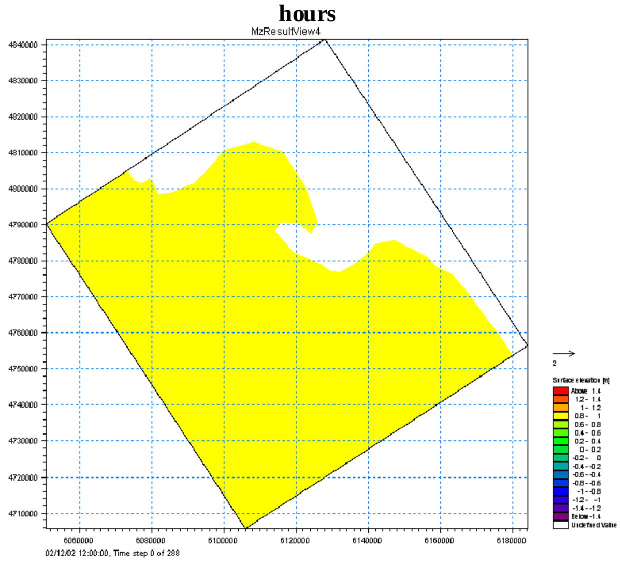
Figure 11. Flow velocity component along the y-axis, A) at the start of modeling, and B) after 24 hours, and C) after 48 hours



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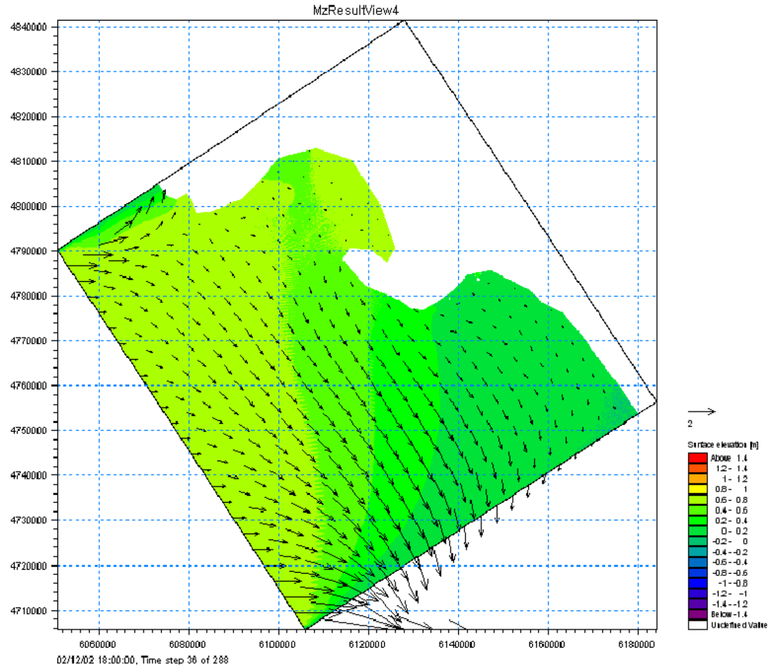
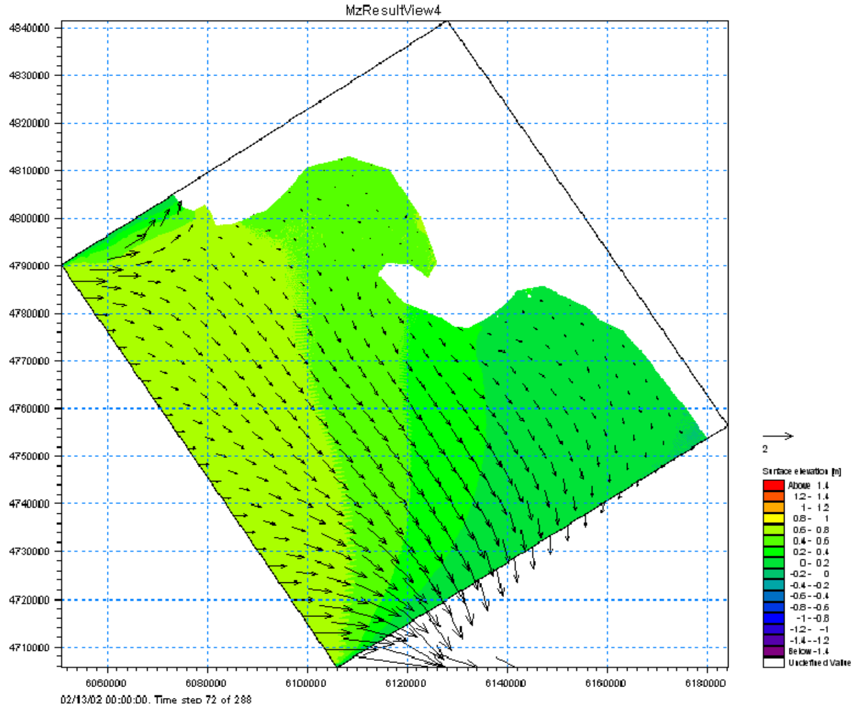


B

Figure 12: Water surface level and flow vectors, A) at the start of modeling, B) after 6 hours



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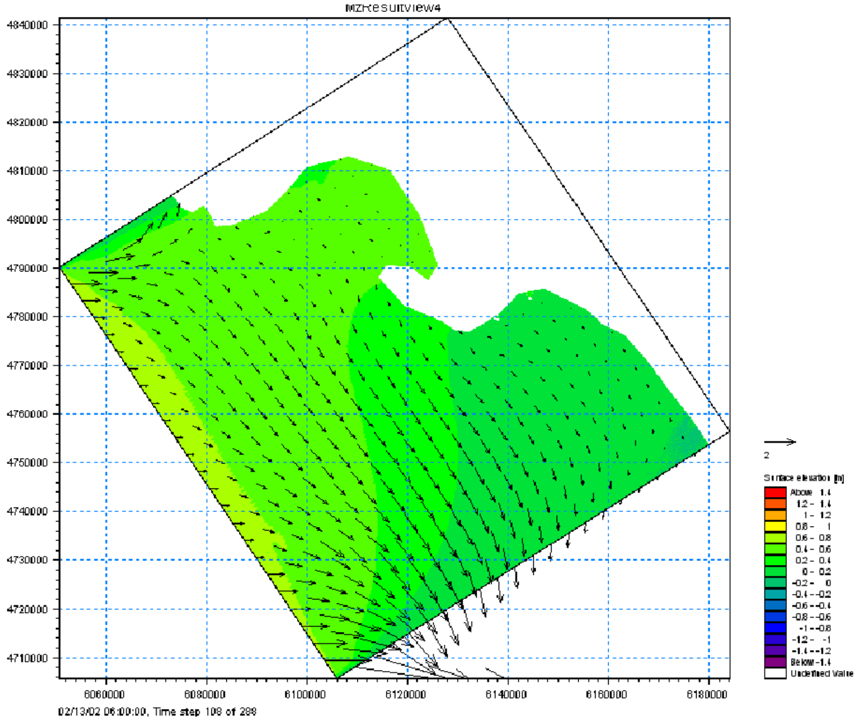

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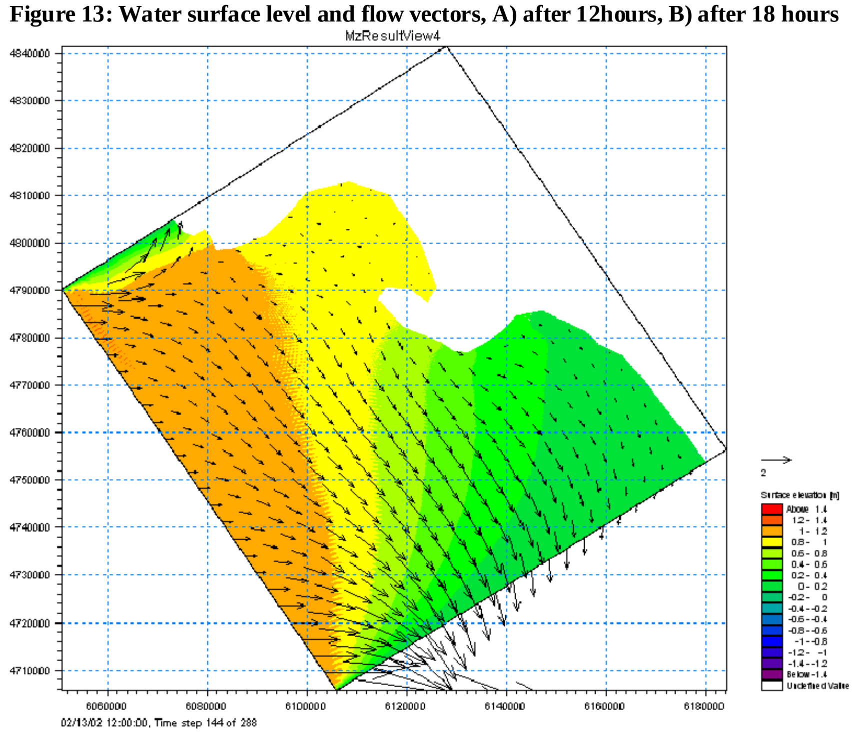
Figure 13: Water surface level and flow vectors, A) after 12hours, B) after 18 hours



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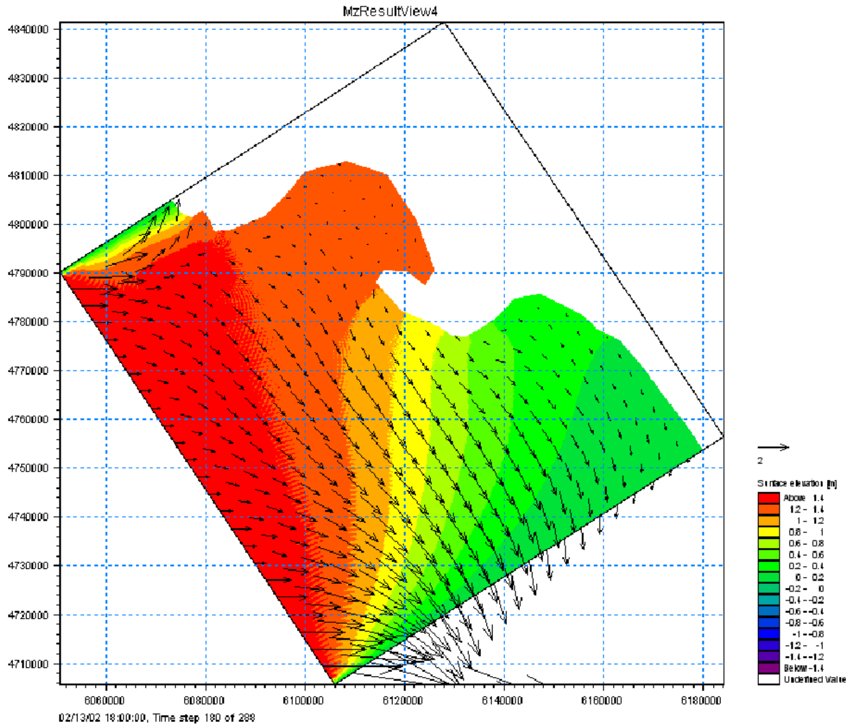

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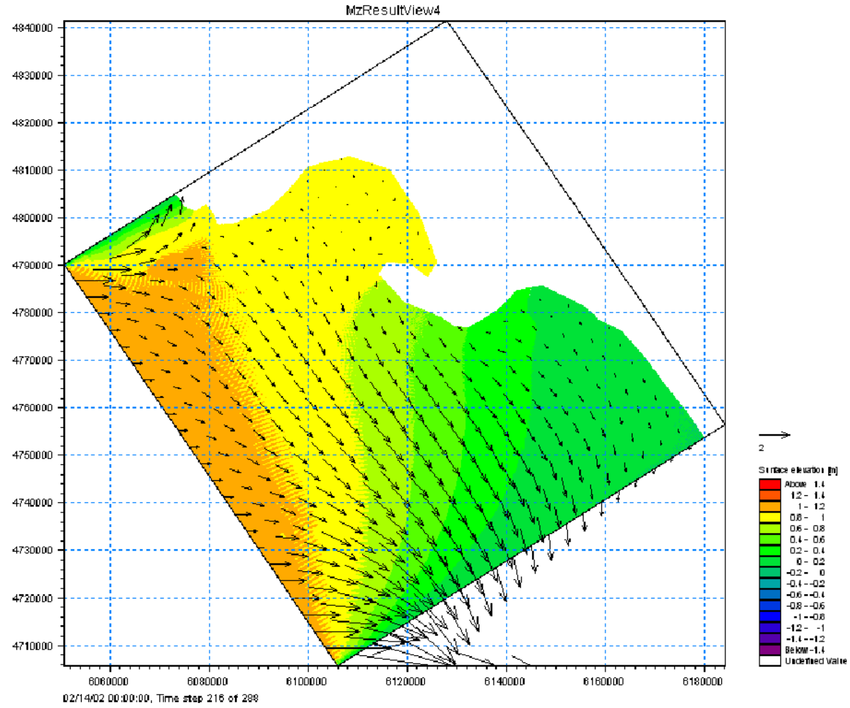
Figure 14: Water surface level and flow vectors, A) after 24 hours, B) after 30 hours



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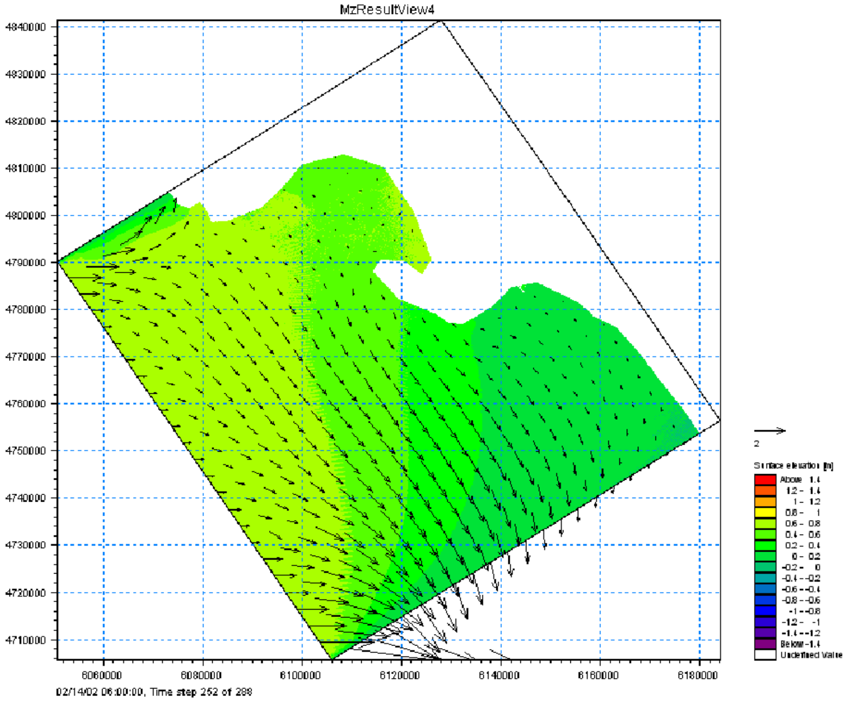

B

Figure 15: Water surface level and flow vectors, A) after 36 hours, B) after 42 hours

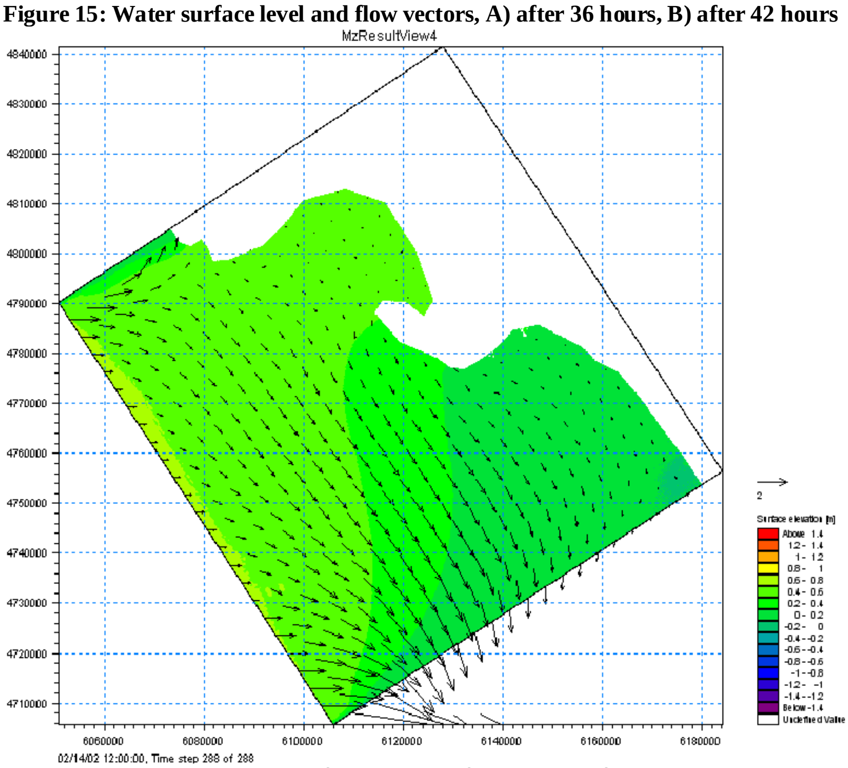

Figure 16: Water surface level and flow vectors after 48 hours

CONCLUSION

We were used Mike 21 software to study of flows in Bushehr coasts. Location Step were considered along the x-axis and y-axis, 100 meters. The maximum depth in study area was 60 maters and time step was 10 seconds.

As a result, Courant number was obtained from 2 times. According to this point that Courant number should be considered about 1, because of to achieve full stability. But in some cases where topography is severe, we will achieve to full stability with Courant number of 5 and 6.So we will reach to an acceptable results as a Courant number from 2 times. Finally, model was run for a 48-hour period. We consider direction and prevailing velocities of wind as fixed for effect of wind. Therefore, wave information considered to consist of velocity and direction were 6 meters per second and 315 degrees, respectively and the friction coefficient of the wind with the water level were a constant amount and equal to 0.0026. Outputs of model are consists of depth variations, level variations and flux and flow.

1. Depth variations: Depth variations showed for modeling period in initial conditions of modeling, after a period of 24 or 48 hours in figure 4. However, numbers of depth variations are small than depth values. So we do not expect deep changes observe tangible in this figures.
2. Transfer of water volumetric: In figures 5 and 6, we showed x and y components of volumetric mass transfer due to wind drift that are identified with P and Q, respectively(positive directions of x-axis and y-axis are along to ease and north, respectively). According to wind velocity and direction and intended friction coefficient to model, the maximum values of the Ekman transport is for 31 hours, after the implementation of model that in this condition, the maximum volumetric Ekman transport along the axis x, is 1035 $m^3/S/m$ .That is related to an area in south-western margin. As the same pattern, the most areas of a mass transfer is in the range of -1 to 80 $m^3/S/m$ .Negative values are related to coastal areas (figure 7). The Biggest values of the mass transfer along the y-axis in related to 30 hours after the implementation of model. In this condition, the maximum volumetric transfer is -204 $m^3/S/m$ .A negative number is indicate that the transfer is in a negative direction of y-axis to south direction. In this pattern, The higher volumetric transmission in areas is in the range of 0- 25 $m^3/S/m$, especially near the coast(figure 8).
3. Changes in water surface level: To view more clearly water level

changes,it is better that we study changes in water level instead of depth changes. For this purpose, it is assumed that all of the study area at the beginning of modeling is a surface level of 1 meter than the average value and after the start of modeling, water level changes is measured to this value. Results is shown in figure 9 related to start modeling (Part A), 24 hours after modeling (Part B) and at the end of 48 hours (Part C). In Part A, as described, it is assumed that all of regions have one meter level to average value. In parts B and C, a category is seen in the water level of the western boundary to the southern and south-eastern border which shows that the western waters have high water level and therefore it is expected that flow is from east to west.

4. Pattern of alongshore flows: The main purpose of this paper is to measure flow velocity of wind and wave. Results related to flow velocity of wind and wave were presented and shown in figures 10 to 16. In Figure 10 is shown U component of flow (flow velocity component along the axis x) at the beginning of modeling 24 hours and 48 hours after the implementation of model. in Figure 10 (Part A) is shown, speed is zero in all parts of model. After 24 hours of running model, the range of U are as follows:

$$-0.8 <= U <= 1.0\, m/s$$

Positive values of speed are indicate velocity components to east and west are negative.Negative values are occurring only in coastal areas.

U component of flow velocity after 48 is as follows:

$$-0.6 <= U <= 1.0\, m/s$$

Also negative values are related to coastal areas. So in general we can say that U component of flow velocity during a period of 48 hours is as $-0.8 <= U <= 1.0\, m/s$ (figures 3- 17). In Figure 11 is shown the component V (flow velocity component along y- axis) at the start of modeling (Part A), 24 (Part B) and 48 hours (Part C) after the implementation model. In Part A, it is determined that flow component at the beginning of modeling of zero is zero in all parts. The general pattern V component of flow velocity after 24 and 48 hours is qualitatively similar pattern with this difference that 24-hour Pattern of 1.0 meters per second is larger than 48-hour Pattern.V components of flow in the coastal areas is as follows:

$-0.5 <= V <= 0.5 m/s$

Figures 12 to 16 shows water level changes with flow velocity vectors, each six-hour. Figure 13 (a) related to beginning of the model that assumes that all parts of level have a surface of one meter. And in this condition flow velocity is zero in all parts. Figure 13 (B) shows that a coastal flow along the coast of beaches that are located in the north- west, are forming to southeast that are mostly less than 0.5 meters per second. Of course, away beach, flows are bigger. Figure 14 (A) and (B) shows flow velocity after 12 and 18 hours after modeling. Flow velocities along the coast are small and less than 0.5 meters per second. Here, away coastline, speed is bigger. There is a significantly flow perpendicular to beach in north-western shores part that is from time of 1 meter per second. Figure 14 (A) shows flow velocity vector after 24 minutes and (B) after 30 hours. It is observed that the predominant flow direction is along northwest to southeast. From start of modeling until 30 hours after it, it seems that flow velocity is almost constant along the coast and we can say, it is less than 5.0 meters per second and Flow velocities are become smaller in alongshore and close to shore (figures 15 and 16).

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