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Estimating Major Crop Water Productivity at Neyshabour Basin and Optimize Crop Area

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Introduction In current situation when world is facing massive population, producing enough food and adequate income for people is a big challenge specifically for governors. This challenge gets even harder in recent decades, due to global population growth which was projected to increase to 7.8 billion in 2025. Agriculture as the only industry that has ability to produce food is consuming 90 percent of fresh water globally. Despite of increasing for food demand, appropriate agricultural land and fresh water resources are restricted. To solve this problem, one is to increase water productivity which can be obtain by irrigation. Iran is not only exempted from this situation but also has more critical situation due to its dry climate and inappropriate precipitation distribution spatially and temporally, also uneven distribution of population which is concentrate in small area. The only reasonable solution by considering water resources limitation and also restricted crop area is changing crop pattern to reach maximum or at least same amount of income by using same or less amount of water. The purpose of this study is to assess financial water productivity and optimize farmer's income by changing in each crop acreage at basin and sub-basin level with no extra groundwater withdrawals, also in order to repair the damages which has enforce to groundwater resources during last decades a scenario of using only 80percent of renewable water were applied and crop area were optimize to provide maximum or same income for farmers.

Materials and methods The Neyshabour basin is located in northeast of Iran, the total geographical area of basin is 73,000 km2 consisting of 41,000 km2 plain and the rest of basin is mountains. This Basin is a part of Kalshoor catchment that is located in southern part of Binaloud heights and northeast of KavirMarkazi. In this study whole Neyshabour basin were divided into 199 sub-basins based on pervious study.Based on official reports, agriculture consumes around 93.5percent of the groundwater withdrawals in Neyshabour basin and mostly in irrigation fields, surface water resources share in total water resource withdrawals is about 4.2percent, which means that groundwater is a primary source of fresh water for different purposes and surface water has a minor role in providing water supply services in the Neyshabour basin. To determine crop cultivation area, major crops divided into two groups. two winter crops (Wheat and Barley) and two summer crops (Maize and Tomato). To accomplish land classification by using supervised method, a training area is needed, so different farms for each crop were chosen by consulting with official agricultural organization expert and multiple point read on GPS for each crop. The maximum likelihood (MLC) method was selected for the land cover classification. To estimate the amount of precipitation at each 199 sub-basins, 13 station data for precipitation were collected, these stations are including 11 pluviometry stations, one climatology station and one synoptic station. Actual evapotranspiration (ETa) is needed to estimate actual yield (Ya). Surface Energy Balance Algorithm for Land (SEBAL) technique were applied on Landsat 8 OLI images. To calculate actual ETa, the following steps in flowchart were modeled as tool in ArcGIS 10.3 and a spreadsheet file. To estimate actual crop yield, the suggested procedure by FAO-33 and FAO-66 were followed. Financial productivity could be defined in differently according to interest. In this study several of these definition was used. These definitions are Income productivity (IP) and Profit productivity (PP). To optimize crop area, linear programing technique were used.

Results and discussion average actual evapotranspiration result for each sub-basin are shown in context. In some sub-basins which there were no evapotranspiration are shown in white. And it happens in those sub-basins which assigned as desert in land classification. In figures 8 and 9 minimum amount of income and profit productivity for wheat and barley is negative, this number means in those area the value of precipitation is higher than value of evapotranspiration, so lower part of eq. 21 and 22 would be negative and in result water productivity would be negative. Since most of precipitation occurs during cold season of the year these numbers are expected. Two sub-basins of 43 and 82 has the value of negative, it means in these two sub-basins

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groundwater are recharging during the year 2014-2015.The maximum value of income and profit productivity belong to wheat and barley which are winter crops and mostly rain fed, so amount applied water would be so low and in result productivity increased. Among the summer crops maize has the most income and profit income which can be interpret due to their growing period and the crop types. Maize has around 110 days to reach to maturity and harvest, on the other hand tomato needs 145 days to harvest. Some plant is C3 and some are C4. C4 plants produce more biomass than C3 crops with same amount of water which leads to more productivity. The results showed that tomato should have the most changes in area reduction (0.2) and maize should have no changes in both scenarios. Crop area should reduce to 66percent of current cultivation area to maintain ground water level and only 6percent reduction in cultivation area would result in 20percent groundwater recharging.

Conclusion to save groundwater resources or even retrieve the only water resource, cultivation area must reduce if the crop pattern will not change. In this study only four crops were studied. It seems best solution is to introduce alternative crop.

Keyword: Land Classification, Geograhic Information System, Groundwater, Remote Sensing, SEBAL Algorithm,