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Locating suitable areas for rain water harvesting

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ABSTRACT

More than 75 percent of Iran is located in arid and semi-arid and faces many hydrological constraints that often are attributed to the lack of rainfall and rainfall distribution. This issue is locating suitable areas for rain water harvestingin Birj and plain however it ismore importance in poor farming communities that are dependent on rain-fed cultivation. To determine the areas those are prone to runoff collection used from a Decision Support System (DSS) and Geographic Information System (GIS)to identify a logical process in relation to harvesting the rainfall and Within this system utilization from Model Builder in Arc GIS 9.3 software. The process defined in this paper uses from runoff capacity for decision and some information such as runoff potential map, distances from residential areas map, irrigated cultivation map and rain-fed cultivation map is inputting in the system. With combination of these maps makes the rain water harvesting prone areas map. The result shows that more than 40 present is in medium class and 32 present is in good class.

Introduction

Extensiveexploiting of natural resources such as land, water and forests causing serious hazards and it is importantfor the local population in the arid and semi-arid region. These hazards makes problems including decrease in soil moisture, high rates of soil erosion, decline of groundwater levels and shortage of drinking water [6].Arid countries faced by many constraints hydrological and this issue are consider able in poor farming communities that are dependent on rain-fed cultivation. In arid and semi-arid region rainfall patterns are not expect in terms of time andamount[7,12]. In appropriate temporal and spatial distribution of the rainfall and recurring events such problem season hydrological constraints in these areas makes the consequences of poverty in term of available water in the soil during the growing season, decrease in products yield potential and finally lead to failproducts[10].Due to ground water resource constraints, brack is hand decline in ground water levelwe encourage to utilization of surface water in arid and semi-arid area sespecially. Surface water is a potential of water resource that result of rainfall and runoff in a watershed then if properly managed can behelptomeet the demand. Rainwater harvesting(RWH) is the perfectoptionfor exclusivityand storesurface runoffforfutureusage especially during periodsthathavelimited access towater[13].RWHis focusto allmethodsthatare used tocollect and storerunoff fromrainfall.

This method can harvest runoff from the roof of houses, land and streams(both inurbanand in theruralarea) and then were storein hydraulic structures orinthe soil profile. The water collectedcanimprove soil moisturestorage and improve groundwater aquifers and finally helpto supply of domestic, agriculture, industry uses[10, 11].Also must be considered that RWH have an impactin reducingand preventingflood damage.

It should be notedthatin vast areasbeforeaddressing thechoice of RWHtechnologiesshould belooking places in terms of hydrological, biophysical and socio-economic potential for these. For this purpose adecision support system(DSS)based on GIS is providing and trying to consider the physical factors, hydrological and socio-economic risk that involved in selecting RWH structures and relying onitfacility time and cost.

DSS is a management tool that helps developers in deciding strategies[8].Jurjakakus and colleagues(2002) can be defined DSS as “An computer appropriate based graphics that with mathematical optimization and simulation models can be mixed and sometimes rules and language algorithms of basic quality are added to it and the purpose is routed to the questions and issues that are pertinent to the specific subject in particular places. In DSS, GIS as a perfect tool for storing, analyzing and managing spatial information is useful and reason able tool for decision making in choosing appropriate places to provide RWH. GIS techniquesare very useful for these studies in storing, analyzing and displaying spatial data that described by the user.

Gupta (1997) and John Esten and Stubby (1990) to predict runoff and the description of the drainage basin were used from GRASS GIS. Humborg and Tauer (1992) used from RS and GIS data for determine locations of RWH. White(1998) in Pennsylvania can be used from SCS model to estimate potential runoff with GIS and data including oil, land use and vegetation. Vina r(2007) suggested that the biophysical criteria are useful in choosing appropriate places RWH and these criteria included suitability of soil, slope and land use. MwengeKahinda et al.(2009) in South Africauseda GIS-based decision support system that deals to evaluate the RWH adoption of this measure in catchment scale. Hekmat Pour et al.(2005) Using decision support systems and GIS capabilities to locate suitable areas of artificial recharge in Varamin plain. Naseriet al.(2009) integrating multi-criteria decision systems and GISto identify suitable locations to spreading artificial feeding. HabibAbadiet al.(2010) using GIS were locate drain water harvesting areasin Tehran province.

In this research located suitable areas to rain water harvesting based on production capacity in the region and social and economic factors are considered in this process. The most basic information that is needed to implement includes a map of

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potential runoff in the watershed that it is the main factor and distance from residential areas and agriculture maps reflected the social and economic dimension. In order to achieve runoff potential map using hydrological models and GIS application are important.

Materials and methods

Case study

Birjand plain inSouthKhorasanprovince of Iran is very important as agriculture, industry, military and urbanization. The plain is located inthe northern part ofthe highlands bagheran with coordinate of 32˚34' until 33˚8 North latitudeand58˚41' until 59˚44 East longitude andstudy area have 3435square kilometersthat 980square kilometersis formed byplainsandother is highlands. Maximumbasinelevationfrom sea level is 2720metersin bagheranand minimumis 1180meters at theoutput of plain.Birjandplainswithaverage annual rainfallof 140mmandan averagetemperature of16.5°C locate in arid area.

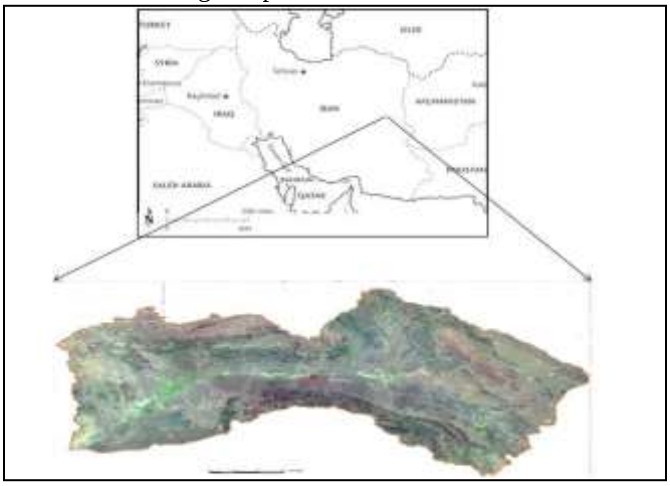

Fig 1. Map of study area

Methodology

In order to determine the capacity of runoff has been used the following data. Topographic mapof 1:25000scale,slopemap ofthe areabased ondigital elevation modelwith a resolution of100m,land use mapwere attained according to satellite images andfieldvisits. Soil texturemaphas been preparedaccording to experts andsamplingthesoil.Hydrologicsoilgroupmapis obtained based onsoilconditionandslope of thearea.Rainfall map created based on an average of 20 years.

Todeterminelocationspotentialis defineda decision support systemto rain water harvestingin9.3 ArcGISsoftware.Input dataincludingrainfall, soil texture, soil samples,thegroundpoints thathave length, width and heightand used from thesatellite imagesandtopographicmaps. The data collected will beentered intoGIS. Preprocessing step is for providing runoff potential mapsthat usingsome dataandmapsfromresidential areasand agriculture. Forthis purposeis made with help of topographic maps, digital elevation modelandslopemap of the area. With the combination of slope and soil texture maps, soil hydrological group map achieved the status of soil classification of infiltration capacity.

Fieldv is its and satellite imagery to assistus inproviding the land use map. Combine this map with the map of soil hydrological groups and tables SCS, produce runoff curve number map. Runoff curve number (CN) is important in the calculation of the characteristics of the runoff. Rainfall precipitation datacan be used formap and it can be usedinthe final calculations.

Results and Discussion

Researcher shows thatLand Use is within eight classes and they are rivers, woodlands and shrubbery, rocky, forests and irrigated agriculture, dryland farming, rangeland, residential areas (Fig 2).

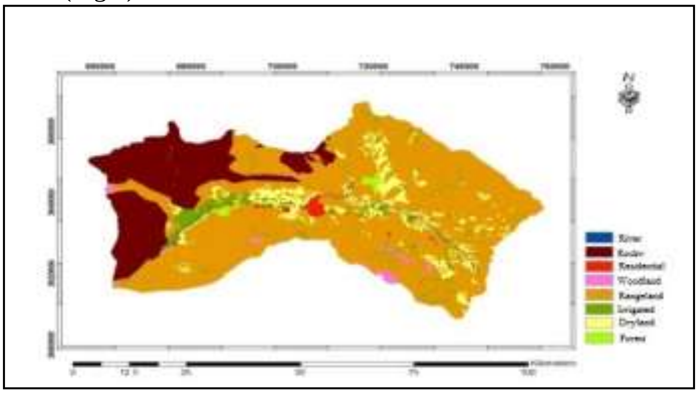

Fig 2. Land Use map of area

Combine of this mapwith themapof soilhydrologicalgroups (Fig 3) and use of SCS table can generate runoff curve number map (Fig 4).

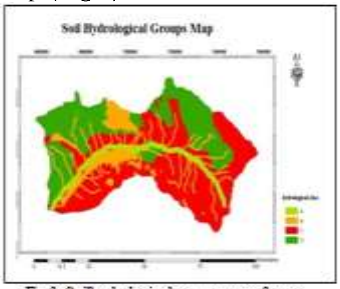

Fig 3. Soilhydrologicalgroupsmap of area

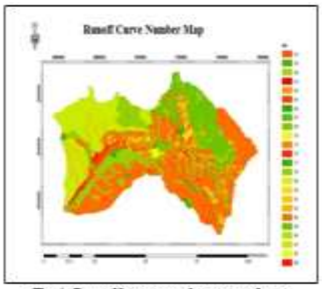

Fig 4. Runoffcurvenumbermap of area

Then with use of long time data in region and with some laboratory research we can make soil map (Fig 5) and finally we make slope map (Fig 6) in this area.

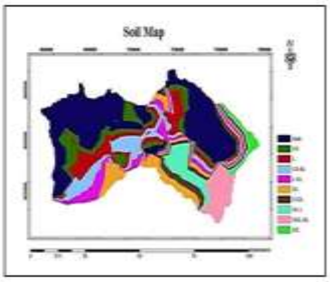

Fig 5.Soilmap of area

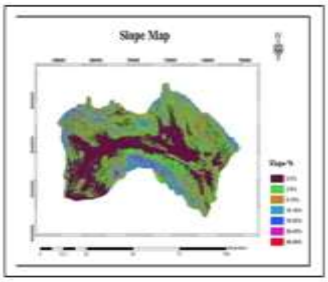

Fig 6.Slope map of area

Finally, with combine of rainfall map and runoff curve number map and base on hydrological relationships that defined in this field could make classification the region in terms of runoff map. This classification is based on three classes that are expressed in 13-30 mm, 30-100 mm and 100-172mm in this region.

As mentioned above, in order to contribute to socio-economic conditions in deciding used from distance of the residential area and agriculture which to be collected in terms of distance maps and GIS capabilities. These maps are operating based on that in residential areas do not allow aquifer projects. Also at distances more than5km from the project is recommended less than other distances. Views of agricultural if being closes the site ofproject will economic because with stored of moisture in residual improve soil moisture conditions in these areas. After the above stepsis begins the most important component of DSS. This step does with using of Model Builder program. After the initial maps of this study in Raster are classifieds base on class which are effective in decision making.

The basic operation that is performed in this phase is WOP[1] (Tab 1).

Tab 1.Weight of each layer

Factors	Runoff Potential	Distance from residential areas	Distance from rain fed lands	Distance from irrigated lands
Weight	39%	22%	19%	20%

Following maps that shows are making in preprocessing steps and the final result of these had classified and have become in raster formats. After weighting the data layers that used in the Model Builder and WOP, the final mapis obtained.

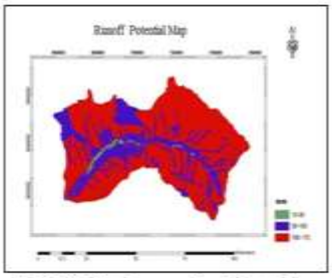

Fig 7. Classification map of runoff potential

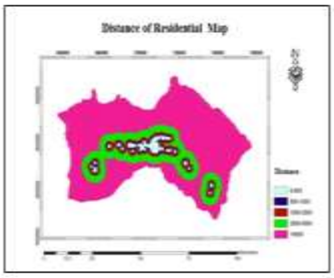

Fig 8.Classification map of residential distance

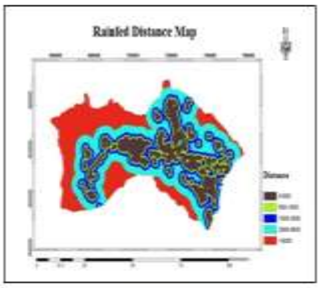

Fig 9. Classification map of rainfed distance

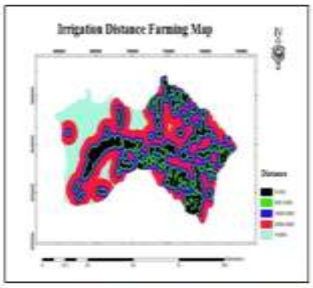

Fig 10. Classification map of irrigation distance farming

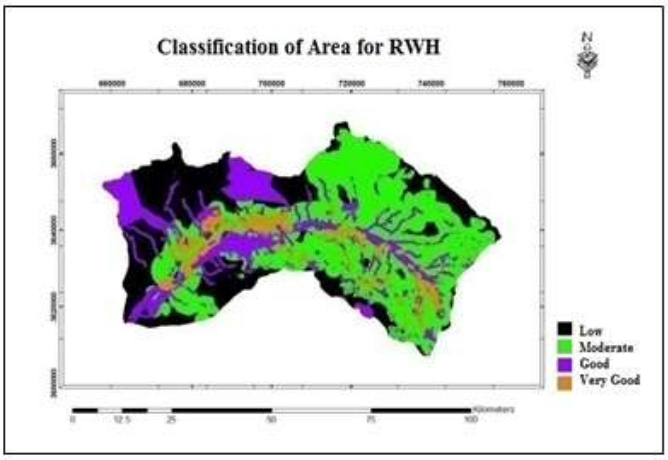

Fig 11. Classification of area for RWH

Conclusion

Because water resources and ground water is Limited and then we are forced to use from RWH to help in this issue. Mainly, in the Northwest and Westregions, as well as a small area in the North and South due to poor soil and high slope although is made a large proportion of runoff but is not suitable for RWH and finally this part is in low potential that is 28.38 present of this case study. Areas with are in moderate class can be seen in the central and eastern of the area and have 43.9 present of this region. In this case shows good and very good class in the central of plains which has a less slope and has more suitable from the soil. In this classification drain age paths and places of them is suitable for implementation of the plan.

Finally must mention that the use of GIS and DSS area new approach for locating of suitable areas in terms of planning these systems.

[1]Weighted Overlay Process

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