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Impacts of Geomorphic Environment on Agricultural Land Use: A Geographical Study of Ch. Dadri District, Haryana

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Abstract

In the present study, geomorphic landscape characteristics and agricultural land use pattern have been studied to evaluate the interlinking between geomorphic landscape and agricultural cropping pattern in Ch. Dadri district, Haryana using satellite images, topographic maps and geographic information system (GIS) techniques. Geomorphological factors directly or indirectly affect the hydro-geological setting of the area, whereas physiographic elements like relief, drainage pattern and slope throw light on the amount of runoff and infiltration. Broadly four types of geomorphic units' i. e. aeolian origin, alluvial origin, alluvial – aeolian origin and structural origin have been identified on the basis of supervised visual interpretation of IRS- Cartosat and ASTER DEM image.

Introduction

In the present study, geomorphic landscape characteristics and agricultural land use pattern have been studied to evaluate the interlinking between geomorphic landscape and agricultural cropping pattern in Ch. Dadri district, Haryana using satellite images, topographic maps and geographic information system (GIS) techniques. Agriculture is lifeline of the local people. The geomorphic landscape of the study area has influenced and press the agricultural land use layout at base level. Presently, farmer is the chief driver of changing pattern of agricultural land use in the area. Resultingly, the cropping pattern has been continuously changed and posed multi-facial challenges' to sustain the agricultural production. There is need to rethink that the present agricultural land use does not suites for the current regional conditions of the natural ecosystems and geomorphic conditions as well as climatic conditions. Multi-dimensional problems have been emerged, viz. desertification, lowering of groundwater table, water logging pockets, low level of carrying capacity of the lands and reduction of vegetative area. It was felt during the field observation that there is an urgent need to study the base level changes in agricultural land use of the area. The adoption of ecological principles-based farming is required in the area. In the modern era, rapidly expanding availability of digital elevation model (DEM) data and release of software tools for GIS hydrological modeling offer a wide range of opportunities for examining the terrain environment and spatial association of natural resources of any area. Digital elevation models are more useful for visual and mathematical analysis of topography, landscapes, landforms and surface water bodies as well as modeling for natural resource conservation, management and development planning at micro level to macro level.

Study Area

Charkhi Dadri District is located in the northwestern part of Haryana, India, bordering the state of Rajasthan. It lies between 28°15' to 28°55' North latitude and 75°30' to 76°45' East longitude. The district has a total area of 1,346 square kilometers. The district is surrounded by Hisar District to the north, Jind District to the east, Fatehabad District to the south, and Bhiwani District to the west. The district headquarters is the city of Charkhi Dadri, which is located in the central part of the district. Charkhi Dadri District has a semi-arid climate with hot summers and mild winters. The average annual temperature in the district is 25°C (77°F). The hottest month is May, with an average temperature of 35°C (95°F), and the coldest month is January, with an average temperature of 15°C (59°F). The average annual rainfall in the district is 500 millimeters (20 inches). Most of the rainfall occurs during the monsoon season, which lasts from July to September.

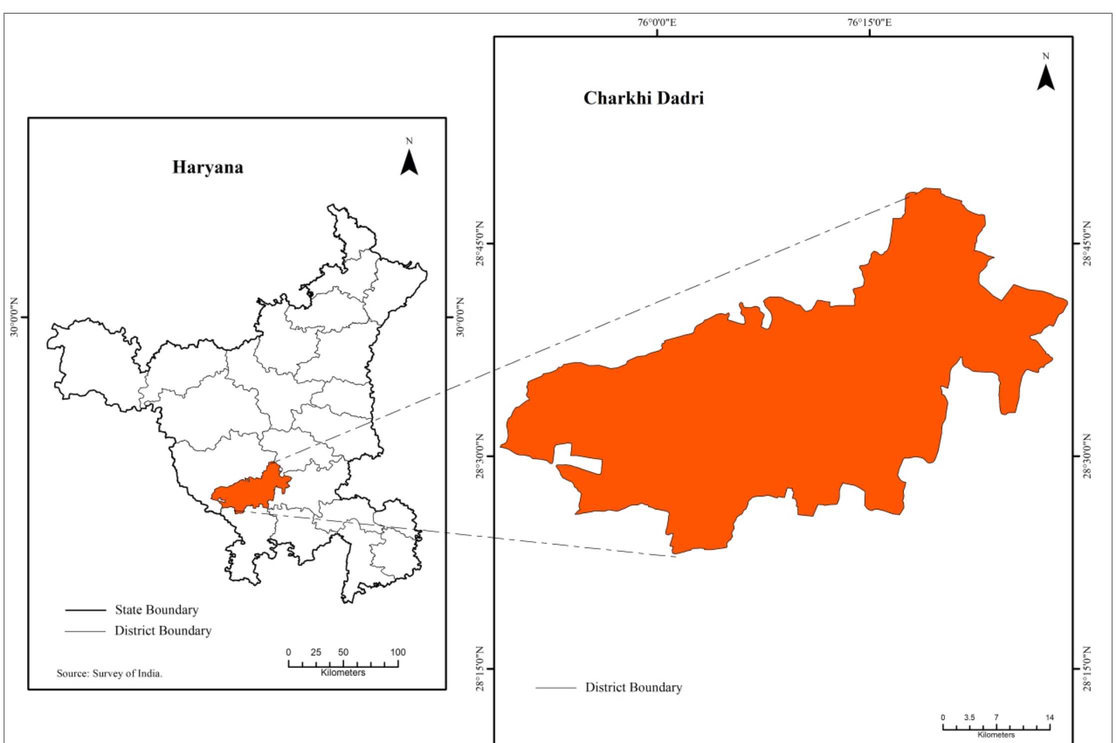

Figure 1

Objectives of the Study

- To map the geomorphic landscape of the study area.
- To study the agricultural land use pattern of study area.
- To examine the interlinkage between geomorphic landscape and agricultural cropping pattern of the area.

Data Base and Methodology

Integrated approach has been used to achieve the objectives of the study. All the attribute data has been integrated with spatial data in GIS software. Supervised visual interpretation technique has been used to the identification of geomorphic features of the study area. Geomorphic units have been identified on the basis of IRS CartoSAT and ASTER satellite DEM images. Cartographic and statistical techniques are also used to compile the tables and various types of diagrams. Supervised classification and on-screen digitization method have been used the various types of thematic layers generation in GIS software. A large number, of GIS software tools have been used to database generation, data integration, representation, visualization, calculation, analysis, map compilation and statistics building. Some specific types of tool/methods have been performed at up to down process of the study.

Result and Discussion

Geomorphic Landscape

Geomorphologically, the area can be divided into following four prominent zones, based on characteristic major and minor landforms and associated features. They have distinct geomorphic form and lithological association. The area under study exhibits action of both alluvial and aeolian geomorphic processes and at places the distinction between the two becomes very complex due to influence of one by the other. Structure and denudation are two important influencing factors in shaping the landforms in hilly terrains. Following geomorphic units have been identified on the basis of supervised visual interpretation of IRS Cartosat and ASTER DEM image.

a. Aeolian Origin
b. Alluvial Origin
c. Alluvial – Aeolian Origin
d. Structural Origin

Aeolian Origin

Wind action major force in altering landscapes in arid and semi arid regions. Wind action erodes; transports and deposits soil, sand, dust and soluble compounds like sodium chloride over long period of time. Depending on the type of action either topographic feature would be developed. Development of such types of topographic features depends upon wind velocity, direction of wind, types of obstacles and their direction which are forces to wind to deposit the material and source of material. In this case a large part of district is covered by aeolian origin landform which is widespread along the CD block Badhra, Charkhi Dadri and some parts of Bond Kalan.

Alluvial Origin

Alluvial landforms are essentially developed by a major river system or by good network of streams. In the case of Charkhi Dadri district, it is fact that there no perennial river/stream and the palaeo course of Dohan rivers forms the only evidence regarding fluvial activity in the past. However, in the eastern part of the district is clear imprint of fluvial landforms are seen in the form of vast alluvial plain dotted by a number of semi active and established dunes**.** Such types of landform are identified and delineated easily using IRS Cartosat satellite DEM image. The older alluvial plains consist of polycyclic sequence of sand,

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silt and clay with nodular as well as concretionary kankar. Such types of geomorphologic unit are essentially a flat area occupying of north, north – east of part of the district.

Alluvial – Aeolian Origin

The alluvial – aeolian origin plain formed over the aeolian plain of geological past. The palaeo river system in this region had left the imprint of the fluvial activities and in the recent past the region has continue overlaid by windblown contributed to larger extent in shaping this unit into transitional one. Expect the remnants of the aeolian landform of stabilised sand dunes /mounds as isolated low relief; the entire unit forms a flat area like older alluvial plain. Such type of geomorphologic unit is seen around Charkhi Dadri, east of Atela and west and south of Kaliana hills. The dunes are marked by east-west linear and they are stabilised (Figure – 1).

Structural Origin

Isolated out hillocks and rocky ridges crops of Aravalli range are continuous reduced in elevation through removal of their material by air, water and human being are the dominant eroding agencies in the district today's. In the case of Charkha Dadri mainly two denudation and structural hills types of structural origin geomorphic landform are noticed in the northern; south and south-central parts of the area (Figure - 2).

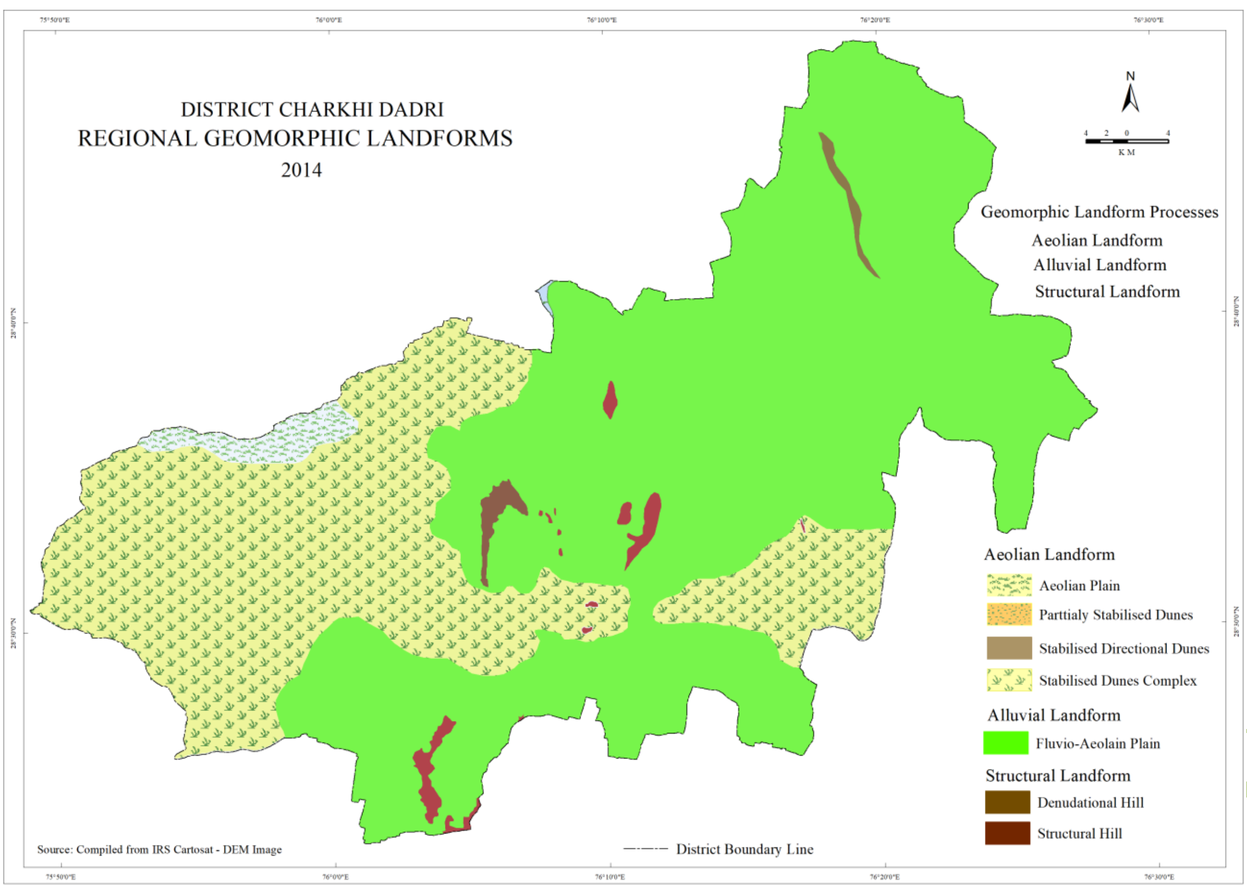
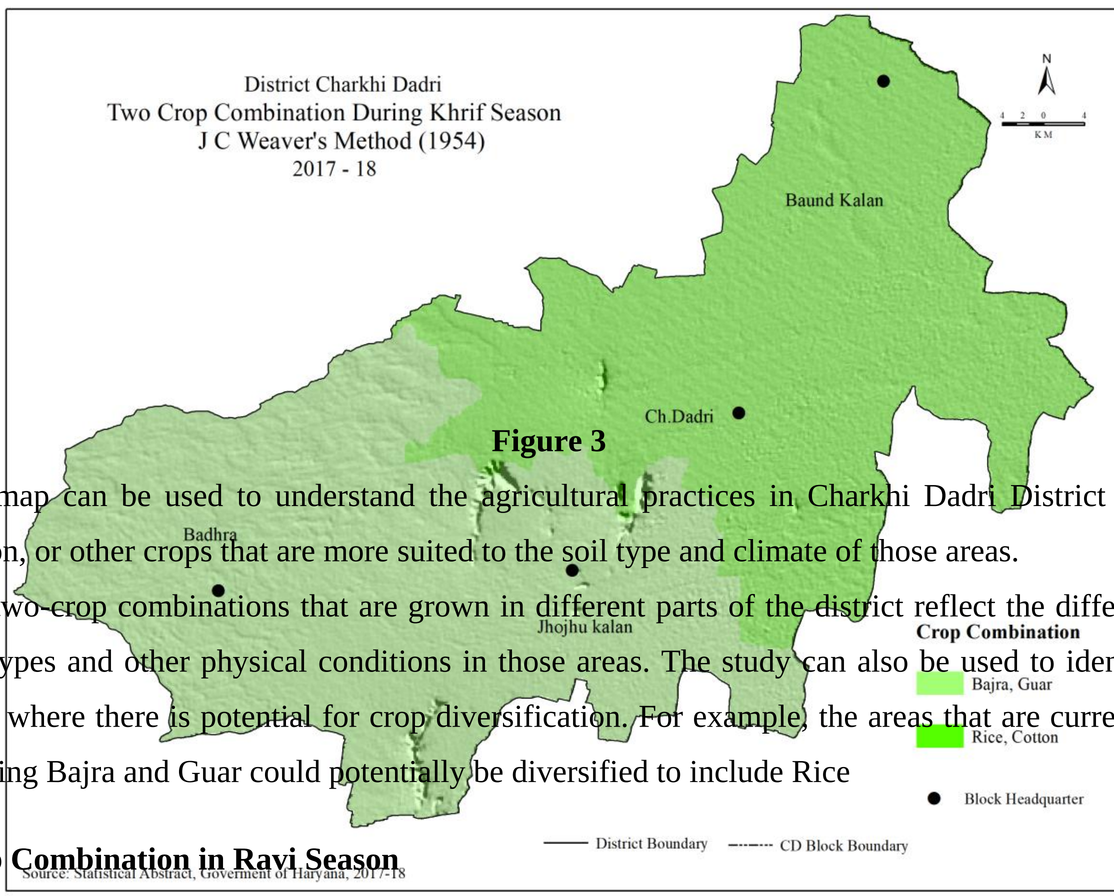


Figure 2

The physic of the district is exposed by combined work of alluvial and aeolian processes. It consists of flat and level plain interrupted from place to place by clusters of sand dunes with few peculiar hillocks and rocky ridges. Water resources point of view regional topography is more important because the eastern and northern low laying area of the district is well gravitationally drained by canal system for flood irrigation the water table is continually rise. On the other side south and south westerns part having high relief and drained by lift canal system the supply of water is very low the water table continually declined. In this region very high level of energy are used to supply the water in canal network as compare to other parts of the area. The cropping pattern of the study area is highly controlled by the topography due to these multi dimension challenges are occurred there to balance the groundwater ecosystem. In overall the regional topography exhibits variety of landform which is greatly affect the multi-directional development of the local livelihood directly or indirectly.

Crop Combination in Kharif Season

The map (Figure 3) shows the spatial distribution of two-crop combinations in Charkhi Dadri District, Haryana, India, during the kharif season. The map is divided into three categories, with different colors representing different two-crop combinations. The map (Figure 3) shows that the most common two-crop combination in Charkhi Dadri District is Bajra and Guar. This combination is found in the central and eastern parts of the district. Rice and Cotton is the second most common two-crop combination, and is found in the western and southern parts of the district. Other two-crop combinations are found throughout the district, but are less common. The map also shows that the spatial distribution of two-crop combinations is related to the physical geography of the district. Bajra and Guar are typically grown in areas with less fertile soil, while Rice and Cotton are typically grown in areas with more fertile soil. The other two-crop combinations are found in a variety of soil types.



Source: Statistical Abstract, Government of Haryana, 2017-18

Figure 3

The map can be used to understand the agricultural practices in Charkhi Dadri District and Cotton, or other crops that are more suited to the soil type and climate of those areas.

The two-crop combinations that are grown in different parts of the district reflect the different soil types and other physical conditions in those areas. The study can also be used to identify areas where there is potential for crop diversification. For example, the areas that are currently growing Bajra and Guar could potentially be diversified to include Rice

Crop Combination in Ravi Season

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The map shows the distribution of two-crop combinations in the district of Charkhi Dadri, India, during the Rabi season. The data is from the year 2017-18. The two most common crop combinations are mustard-wheat and wheat-mustard. These crops are grown together because they have complementary nutrient and water requirements. Mustard is a deep-rooted crop that can access water from deeper layers of the soil, while wheat is a shallow-rooted crop. This allows the two crops to grow together without competing for resources.

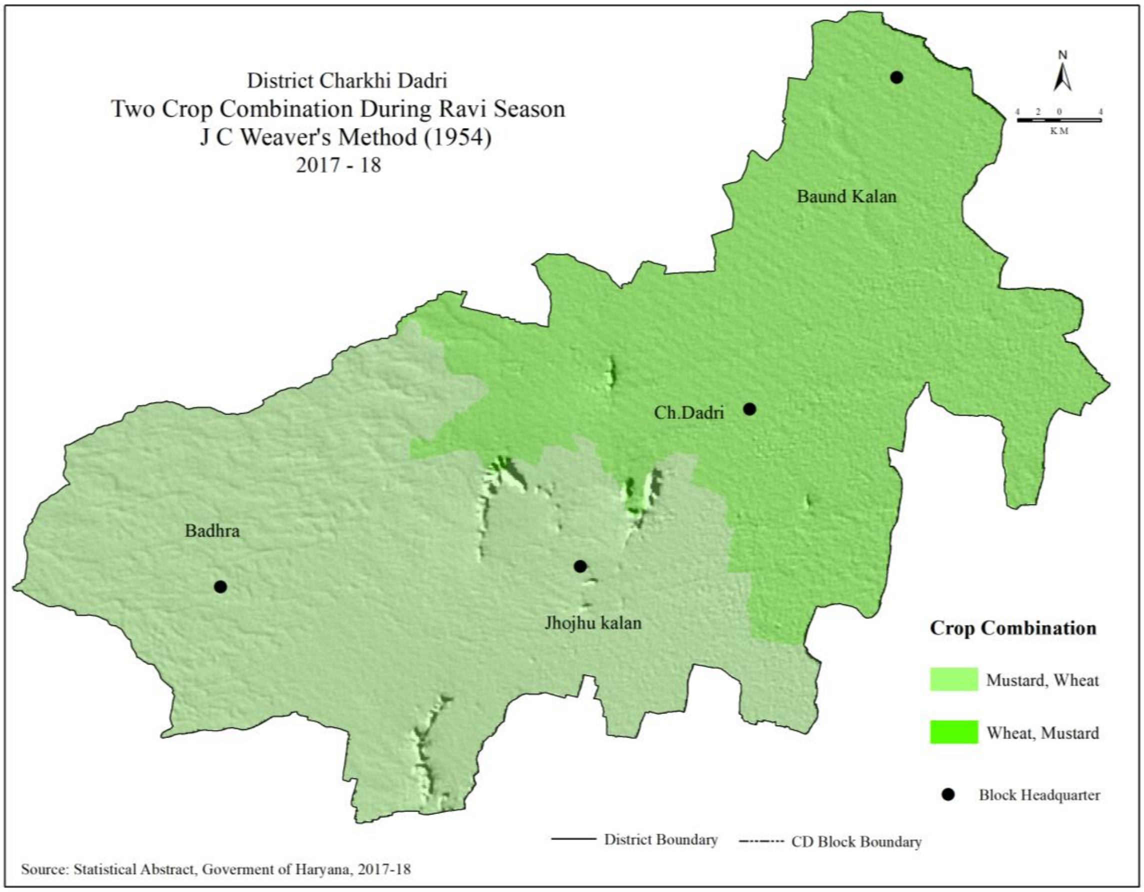

Figure 4

The mustard-wheat crop combination is the most common in the central and southern parts of the district. This is because these areas have more loamy and sandy loam soils, which are well-suited for the cultivation of mustard. The wheat-mustard crop combination is more common in the northern and western parts of the district, where the soils are more clayey and have higher water retention capacity. The map also shows that the two-crop combination of mustard-wheat is more common in the western parts of the district, while the two-crop combination of wheat-mustard is more common in the eastern parts of the district. This is likely due to the fact that the western parts of the district receive more rainfall than the eastern parts. Mustard is a more drought-tolerant crop than wheat, so it is better suited to areas with less rainfall.

Conclusion

In conclusion, the geomorphic landscape characteristics and agricultural land use patterns in Charkhi Dadri district, Haryana, are closely intertwined. The district's geomorphic features, including alluvial and aeolian landforms, have played a significant role in shaping the agricultural land use layout. Presently, farmers are the primary drivers of change in the district's agricultural land use, leading to continuous modifications in cropping patterns and posing challenges for sustainable agricultural production. The current agricultural land use practices do not align with the prevailing regional conditions, including natural ecosystems, geomorphic features, and climatic conditions. This has resulted in multi-dimensional problems such as desertification, groundwater depletion, waterlogging, reduced land carrying capacity, and diminished vegetative cover. There is an urgent need to adopt ecological principles-based farming practices and reconsider the current agricultural land use patterns to ensure long-term sustainability. The adoption of modern technologies, such as digital elevation models (DEM) and GIS tools, can provide valuable insights into the terrain environment and spatial relationships between natural resources, facilitating informed decision-making for sustainable land management and agricultural planning.

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