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GEOMORPHIC CHARACTERISATION OF GWALIOR

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ABSTRACT:The earth's forms are primarily due to hypogene or endogenous processes. Geomorphology is the science and study of landforms on earth and the geomorphic units are classified on the basis of differential erosional process. The different climatic environments produce different suites of landforms. In the present study, various geomorphic units such as denudational hills, residual hills, pediments, structural hills and alluvial plains have been studied.Findings show that the dominating landforms of the city greatly have an impact on the climate of the city.

Index Term: **Bowl shaped depression, Bundelkhand Granite, Geomorphic Unit, Urban Heat Island**

I. INTRODUCTION

The development of landforms depends on the climatic regime, the operative processes of denudation and sedimentation during and after their formation as well as their intensity in time and space, and the rocks and materials (their composition, nature and structure) acted upon. Man made or anthropogenic causes also affect landform development. Gwalior, the historical city of Madhya Pradesh, is well known for its magnificent Fort and the Royals of the Scindia dynasty worldwide. It is the fourth largest city, situated in the northern part of the state of Madhya Pradesh. It consists of three distinct urbantownships – Gwalior in north, while Lashkar, about 3 km to the southwest, and Morar towards east (which covers the cantonment area) of Gwalior Metropolitan City respectively (Fig.1). It covers an area about 245.7sq.km,confined between latitudes 26º10'- 26º15' N and longitudes 78º07'-78º15' E which falls in Survey of India topographic sheet no.54J/4 .The main purpose of this study is to identify the geomorphic features and its impact on the climate of Gwalior city.

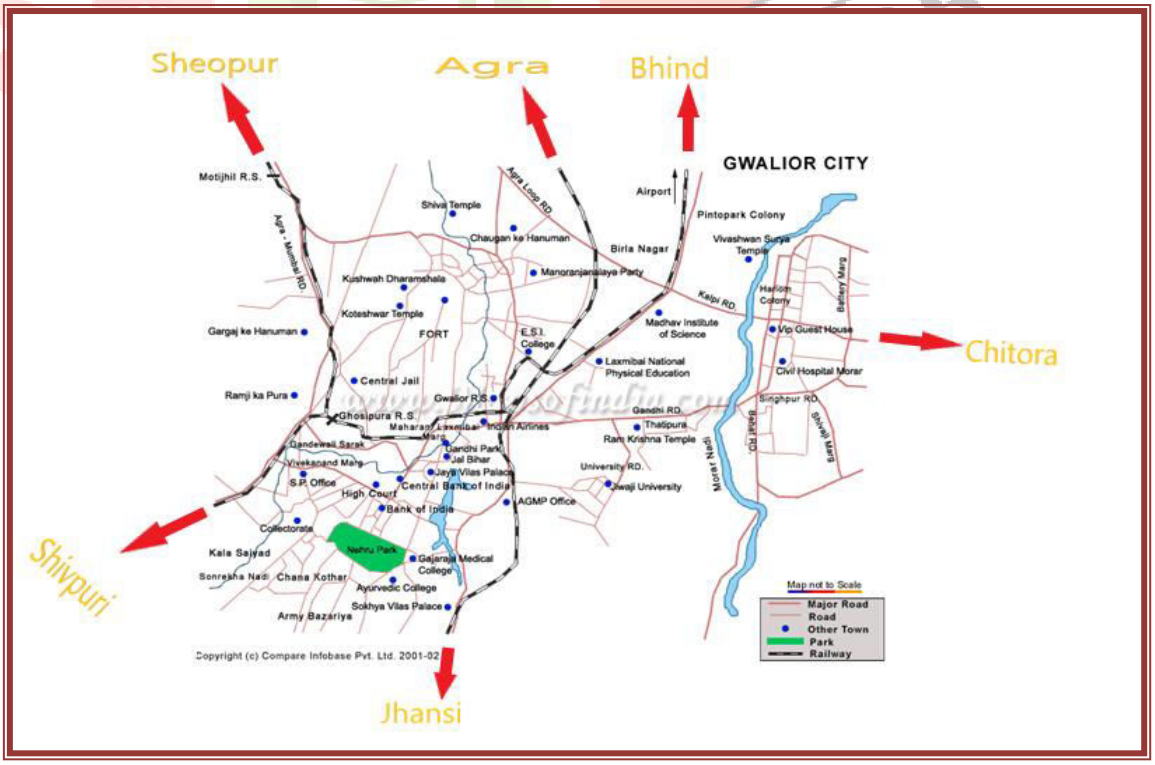

Figure1: Location Mapof the study area

II. METHODOLOGY

The present study has been carried out using remote sensing techniques. Detailed lithological and geomorphological studies were carried out using Erdas Imagine 8.6 and Arc GIS9.0. Visual interpretation techniques were applied for delineating different geomorphic features of the area**.**

III. GEOLOGICAL SETTING OF GWALIOR

The oldest rocks of Indian Stratigraphy are exposed in this region. The intracratonic Gwalior basin is situated on the northwestern fringe of Bundelkhand massif. The Gwalior Group of lithounits rest unconformably over Bundelkhand Granite massif and comprise of basal arenaceous Par Formation(type area) overlain by volcano-sedimentary sequences of Morar Formation consisting of ferruginous shale with bands of chert, jasper and limestone (Pateriya and Singh,1994). Igneous activity contemporaneous with sedimentation is manifested by sills, dykes and lava flows within the Morar Formation at different levels.

The Gwalior Group of rocks are similar to that of Bijawar Group but the sequence at Bijawar dips due south whereas at Gwalior they dip due north. Vindhyan strata which show the Gwalior basin like sequence, dominated by quartzite at the base, ferruginous shale with chert and jasper pointing to shallow water conditions. The Gwalior Group of rocks, also contain coarse to fine grained dolerite sills and dykes, which are exposed at the base of the Gwalior Fort as well as in various other localities (Fig.2).

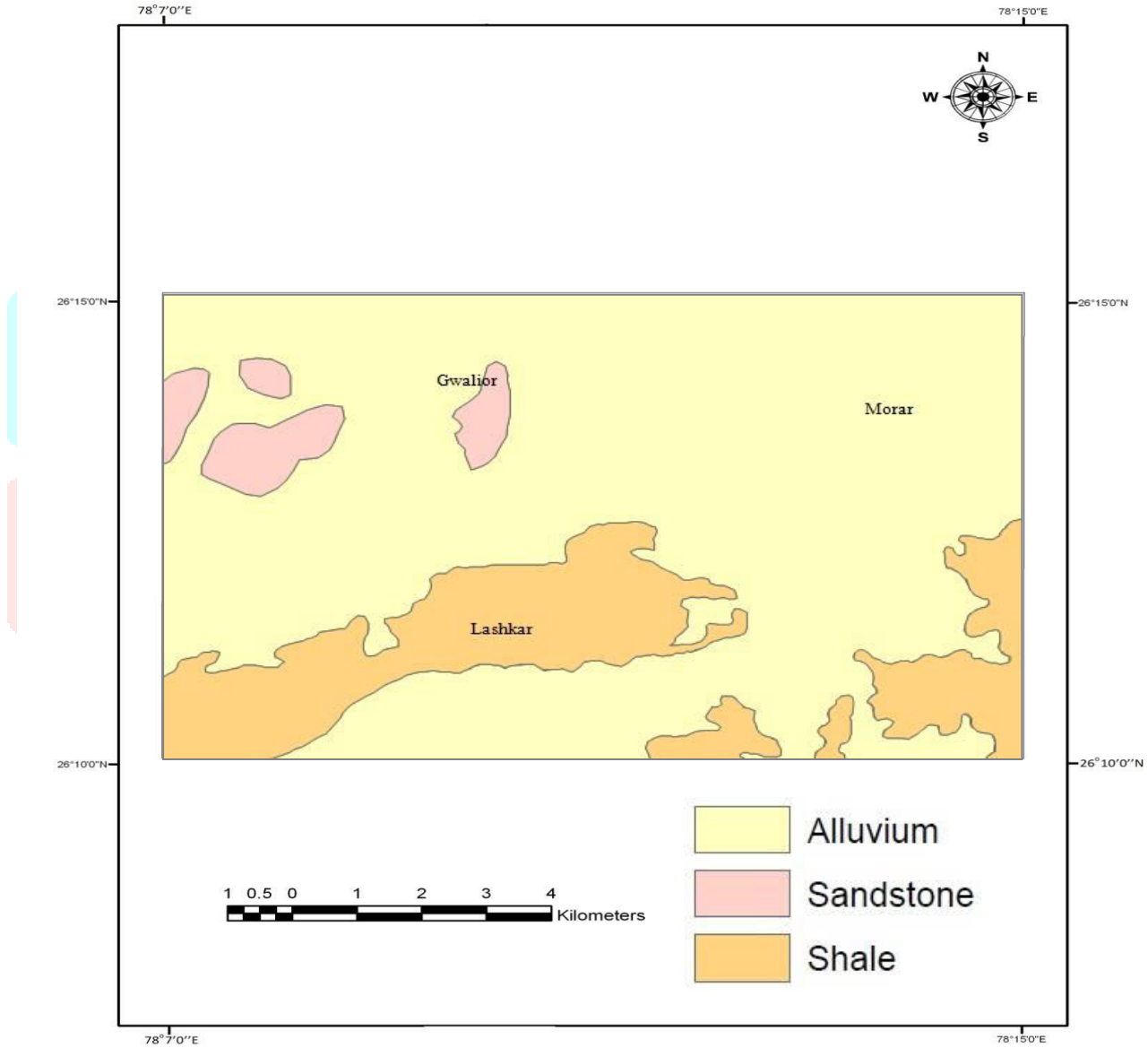

Figure2: Lithological Map of the study area

IV. GEOMORPHIC SETTING

The area consists of three types of geomorphic landforms viz. denudational, structural and depositional (alluvial plain). Denudational landforms are further Grouped as residual hills and pediments (Fig.3).

(a)Denudational Hills

Denudational hills are formed due to differential erosion and weathering so that a more resistant formation or intrusion stand as mountains/hills (NRSA, Technical Guidelines, 1995). The hills are mainly composed of granites, sandstones and limestones. Long continued weathering and erosion of the exposed rock units have produced denudational hills in the area. Most

of these hills are covered by scanty vegetation and carry a thinner soil cover. These denudational hills occur in southern and western portions with high relief.

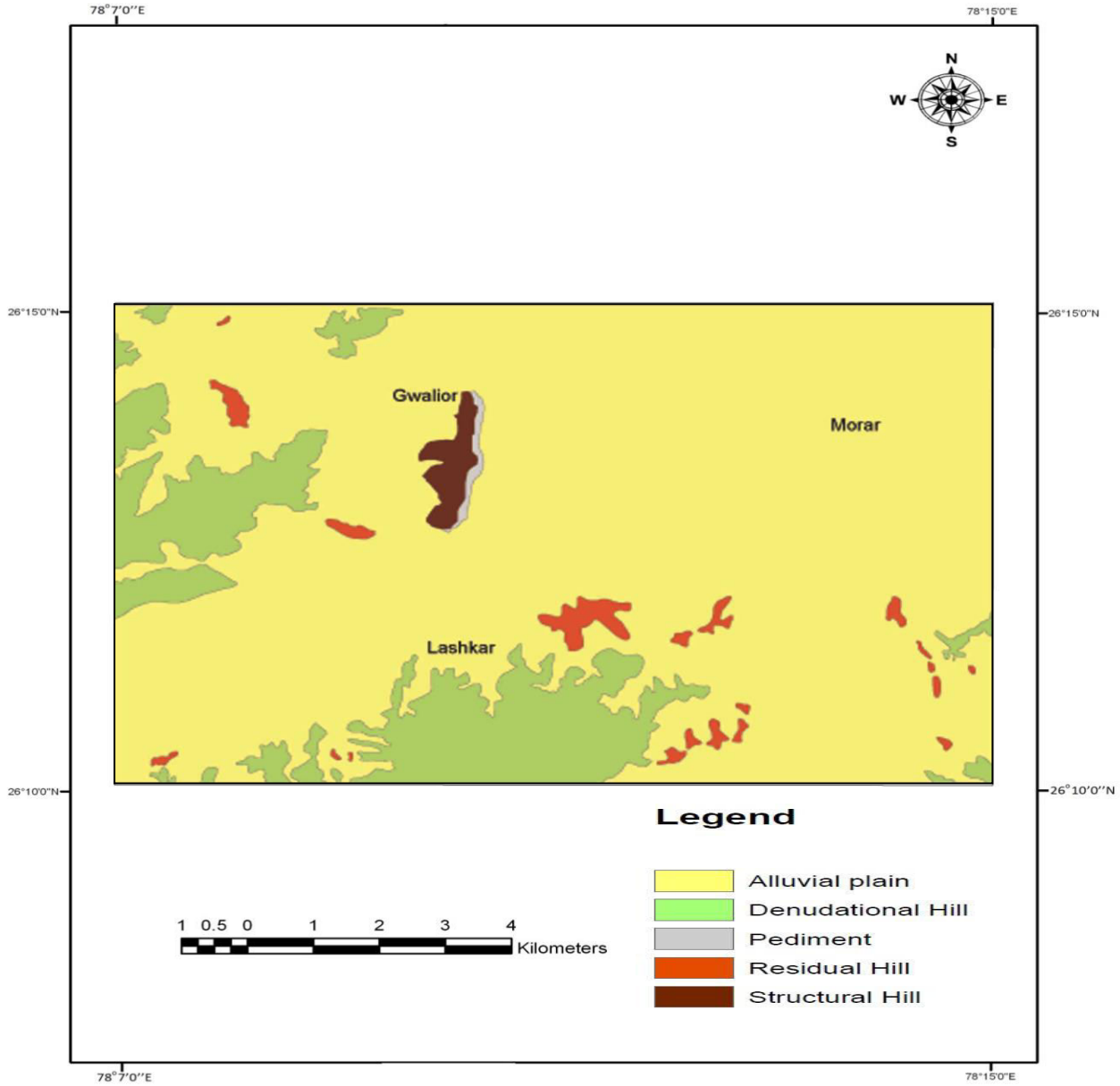

Figure 3: Geomorphological Map of the study area

(b) Residual Hills

These are isolated low relief terrain formed due to differential erosion so that a more resistant Formation stands as residue like small hills .These are the resistant isolated, steep sided, usually smoothened and rounded hills or rock outcrops of circumdenudation rising abruptly from and surrounded by an extensive and nearly level plains in tropical regions (Gary et al., 1972). The residual hills are present mostly in the southern part.

(c) Pediments

Pediments are gently sloping smooth surface of erosional bedrock, developed at the foot hills and consisting of a veneer of detritus and broad undulating rock floor. These pediments are located in the lower reaches of the hill ranges and are generally formed by the loose fragments, generated from the hill ranges due to erosional activities and were deposited in the foot of the hill ranges by mass movement process like landslides, soil creeps, etc. These landforms are observed at the foot of Fort hill.

(d) Structural Hills

These are linear to arcurate hills exhibiting definite trend lines of varying lithology. They are associated with geologic structures like folds, faults, joints, bedding, current bedding, ripple marks, lineaments etc (Singh and Singh, 2011).The Fort hill scarp is observed in the central part of the area and is mainly composed of Kaimur sandstone.

(e) Alluvial Plains

These are the broad expansion plains formed by major rivers and are generally found in the lower reaches of streams comprising of sand, silt, clay etc. They occur on both sides (northeast and southeast) of the Morar and the Swarnrekha rivers. They cover most of the area consisting of recent deposits .The alluvial plains are good for agriculture.

V. GEOMORPHIC IMPACT ON CLIMATE

Gwalior city is surrounded by hills of Gwalior Group occurring on three sides of the city.The Hanuman hill and the Gupteshwar hill in the west, the Guda Gudi hill in the south, the Bhadawana hills andBateshwar, Shanishchara, Padawali, Mitawali etc. hill ranges to the east and northeast whereas isolated and other low relief hill ranges in the northern side of the city. Theseare the dominating landforms of the study area and are rich in iron content and are either barren or having scanty or thin vegetative cover. The Fort hill forming an escarpment is composed of Kaimur sandstone and lies to the west.The central portion of the main city is inhabited in a bowl shaped depression surrounded by these hill ranges.

The Gwalior region experiences scorching heat in the summer whereas freezing cold in the winter season. As the hills surrounding the main city are rich in Fe content,they absorb enough heat from sun during peak summer days of longer duration as such, there is sufficient increase in daytime temperature rising upto 45-47^{0}C. As the rocks are bad conductors of heat, they take much longer time to cool down during shorter nights of summer resulting warmer wind blowing even in the early morning time. On the contrary, in the winter season, these rocks sufficiently cool down during the longer nights and do not get enough time period to become hotter in daytime.This leads to a very distinguished climatic behavior where the temperature difference between day and night ranges between 10^0 - 15^{0}C or even more. However, the overall temperature at Gwalior remains either 2^{0}C higher or lower than Delhi during summer or winter respectively.

The bowl shaped depression of the city almost acts like an open hearth during the peak summer days resulting in the development of an Urban Heat Island (UHI) where the natural passage of the warmer wind is being blocked by the surrounding high hills. This causes excessive sweating and hot feeling and increases discomfort to the people as if they are sitting in an open hearth potentially raising the threat of heat stress and mortality.

On the onset of monsoon period, a quite interesting aspect occurs as the city gets very scanty or almost nill rains because of the fact that the rain clouds traversing over the bowl shaped central portion of the city become hotter and move away to the cooler countryside areas like Tighra, Ghatigaon, Tekanpur, Bhadawana etc. where medium to heavy rainfalls occur very often. The area encompassing the main city gets normal rain only after some progress in the period when it becomes sufficiently cool due to rains in the surrounding areas and the clouds over the city get transformed easily into rain drops.

Landforms affect climate by altering the wind and rate of evaporation, which cause changes in temperature, humidity and precipitation. When storm fronts run into landforms such as hills surrounding the city, rain clouds are blocked. This causes the upwind side of the landform to receive plentiful rainfall, while the downwind side to receive less rainfall. This is the reason why Gwalior city receives less rainfall and the area surrounding the city gets plentiful rainfall during the monsoon.

VI. CONCLUSION

The results are discussed in this paper. The geomorphic units mapped aredenudational hills occurring in southern and western part of the city with high relief, residual hills mostly in southern, pediments at the foot of the Fort Hill, structural hills at the central part,i.e. the Fort Hill and alluvial plains on both the sides of the Morar and the Swarnrekha rivers. The geomorphic landforms surrounding the city definitely have an impact on the local climatic behaviour of the city. The hills which surrounds the city acts as a barrier. Extreme temperature in summer, chilling temperature in winter and less rainfall in monsoon are associated with thedominating landforms of the city.

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