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A Review On Application Of Geospatial Technique In Groundwater Potential Zonation

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Abstract: Water Plays A Very Crucial Role In The Development Of A Country. The Surface Water Resources Are Unable To Complete The Need Of Water. The Dependency Of Groundwater Is Too High As Compared To The Surface Water, But Still Proper Explotation Of The Resources Of Groundwater Has Not Yet Been Done. This Study Reveals The Application Of Geospatial Technique And Geographical Information System (GIS) To Delineate Different Groundwater Potential Units. With The Help Of Geospatial Data, Numerous Thematic Layers Can Be Created I.E. Geology, Geomorphology, Slope, Drainage Density, Land Use And Land Cover, Lineament Density Map, Structure. Rainfall Data Can Be Taken From The Meteorological Department. Slope Map Of The Area Can Be Generated Through DEM Of The Area. Using GIS Rank And Weightage Are Given To Carry Out The Groundwater Potential Map Of The Area.

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Keywords: DEM (Digital Elevation Model), GIS (Geographical Information System), Geospatial Data.

I. INTRODUCTION

Water Is The Most Important Supply For Mankind And The Environment. One Of The Largest Sources Of Water Present Below The Earth's Surface Is Groundwater. Groundwater Can Be Defined As, Water That Occupies All The Pore Spaces In A Rock Or The Water That Lies Below The Water Table. Its Availability Depends On Rock Type And Its Physical Properties Like Porosity, Permeability, And Transmissivity And Storage Capacity(Adham, Jahan, Mazumder, Hossain, & Haque, 2010). It Also Depends Upon The Expansion Of The Area, Rainfall Of The Area, Increasing Requirement, And Utilization. This Study Is Focused On The Use Of Remote Sensing And GIS For Collection, Integration And Analysis Of Data For The Potential Zonation Of Groundwater.

Remote Sensing Is A Technique Of Getting Information About Any Object By Using The Data Recorded By A Device That Is Not In Physical Contact With The Object Or Area (Arkoprovo, Adarsa, & Prakash, 2012) The Use Of Remote Sensing Data In Extraction And Demarcation Of Different Lithological, Structural And Geomorphological Features Is Well Known (Kaya & Analysisi, 1992) At Present, Satellite Data Is Being Used Very Frequently For The Interpretation Of Groundwater Potential Zone. Satellite Remote Sensing Data Is Not Only Cheap And Easy But On The Other Hand, It Is Trustworthy As Well . This Data, Which Is Most Precise, Broad And Obtainable To A Uniform Standard, Fullfils The Vital Necessity Of Data In The Geographical Information System (GIS) Domain. (Arkoprovo Et Al., 2012)

GIS Is Software Designed To Store, Manipulate, Analyze, Manage, And Present All Types Of Geographical Data. Combination Of The Data On The Controlled Environment Is Best Achieved Using GIS That Is An Efficient Tool For Storage, Management, And Salvage Of Spatial And Non-Spatial Data As Well As For Combination And Examination Of This Information For A Significant Resolution. (Saraf & Choudhury, 1998).

These Two Methods, Remote Sensing And GIS Has Proved To Be The Best Techniques For Groundwater Studies. Remote Sensing Gives An Idea For Best Observation And A More Orderly Analysis Of Various Geological And Geomorphological Units.

Various Researchers Has Examined Diverse Criteria For Delineating Groundwater Potential Zones. (Srivastava & Bhattacharya, 2006), (Krishna Kumar, Logeshkumaran, Magesh, Godson, & Chandrasekar, 2015) And (Krishna Kumar Et Al., 2015) Have Used The Lineament And Hydro Geomorphology Based Approach In Delineating

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Groundwater Potential Zone. While (Jasrotia, Kumar, & Saraf, 2007) Have Used Remote Sensing And GIS In Delineating Artificial Recharge Sites.

II. Application Of Remote Sensing And GIS In Groundwater Potential Zonation

Remote Sensing Data Are One Of The Major Sources For Providing Information On Land And Water-Related Subjects. Remote Sensing Provides Multi-Spectral, Multi-Temporal, And Multi-Sensor Data Of The Earth's Surface (Saraf & Choudhury, 1998). One Of The Most Usefull Benefit Of Using Remote Sensing Data For Hydrogeological Investigations And Monitoring Is Its Capability To Generate Information In The Spatial And Temporal Domain, Which Is Very Crucial For Successful Analysis, Prediction And Validation(Saraf & Choudhury, 1998). The Use Of Remote Sensing Technology Involves A Large Amount Of Spatial Data Management And Requires An Efficient System To Handle Such Data. In Groundwater Potential Zonation Study Involves The Study Of Geology, Geomorphology, Slope, Drainage Density, Land Use And Land Cover, Lineament Density Map, Structure And Rainfall. The Entire Thematic Layer Can Be Generated Using A Remote Sensing Image. These Data Being Digital In Nature, Can Be Efficiently Interpreted And Analyzed Using Various Kinds Of Software Packages (E.G., PCI, ENVI, ERDAS IMAGINE, Etc.)

The Geographic Information System (GIS) Has Came Out As An Efficient Tool For Holding And Manupulation Spatial Data And Assessment In Different Areas Such As Engineering And Environmental Fields(Stafford & Mcmichael, 1991), (Goodchild, 1993). The GIS Software Provides A Suitable Alternative For Efficient Management Of Large And Complex Remotely Sensed Data. The Remotely Sensed Data Can Be Digitized Using GIS, It Also Helps To Integrate Conjunctive Analysis Of Large Volumes Of Multidisciplinary Data, Both Spatial And Non-Spatial. The Simulation Modeling Of Subsurface Flow And Transportation Process Canbe Possible Using Remote Sensing And GIS In Both Saturated And Unsaturated Condition. Satellite Data Provide Quick And Useful Baseline Information About The Factors Controlling The Occurrence And Movement Of Groundwater Like Geology, Lithology, Geomorphology, Soils, Land Use/Cover, Drainage Patterns, Lineaments, Etc. ((Hussein, Govindu, & Nigusse, 2017)). Using Remote Sensing And GIS The Groundwater Potential Zone Can Be Inferred In The Following Steps:

A. Data Collection

Data Can Be Collected From Various Satellite I.E. LANDSAT Satellite, SPOT Satellite, IRS Satellite, IKONOS, Quick Bird, Etc. These Data Can Be Purchased And Few Are Available Free Of The Cast On The Internet, Rainfall Data From The Indian Meteorological Department, Toposheet From The Survey Of India And Secondary Well Data From The Central Groundwater Board (CGWB).

B. Data Analysis

The Main Aim Of Data Analysis Is To Carry Out The Study And Interpretation Of Satellite Data To Produce Thematic Maps I.E., Geology, Geomorphology, Slope, Drainage Density, Land Use And Land Cover, Lineament Density Map, Structure And Rainfall. This Should Be Followed By Processing The Digital Images Using The Various Processing Techniques, Viz., Enhancement, Filtering, Classification And Other GIS Processes. Subsequently, Selective Field Checking Was Carried Out ((Arkoprovo Et Al., 2012)).

C. Spatial Database Building

Arc GIS Provides Various Tools To Create A Database Of Features, Attribute Tables, Geometric Network And Other Data ((Patil, Mohite, & Khare, 2013)). All The Available Database Should Be Integrated In The Digital Form And Correctly Registered To Get The Spatial Components Overlaps Suitably, After That The Transformation And Conversion From Raster To Vector, Gridding, Buffer Analysis, Box Calculation, Interpolation And GIS Processing ((Arkoprovo Et Al., 2012)). Finally , We Will Get Derived Thematic Maps Such As Geomorphology, Drainage Density, Geology, Lineament Density, Surface Water Body, Structure, Slope, Land Use Land Cover Etc.

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D. Spatial Data Analysis

Spatial Analysis Is A Significant Process Using Location Of Study Area Together With Attribute, Table Analysis, And Classification ((Patil Et Al., 2013)). In This Stage, The All The Thematic Maps Has To Be Set To Extract The Spatial Features That Are Applicable To The Groundwater Potential Zone. Polygon In Each Of The Thematic Layers Should Be Categorized And Suitable Weights Are Given To Them.

E. Spatial Data Interpretation

This Stage Involves Combining The Entire Thematic Layer And Their Interpretation In GIS Using A Suitable Methodology.

III. METHODOLOGY

All The Thematic Maps Of Geology, Geomorphology, Slope, Drainage Density, Land Use And Land Cover, Lineament Density Map, Structure, And Rainfall Have To Be Generated, Based On Visual Interpretation Of Satellite Data And Ground Survey. A Rainfall Map Of The Area Can Be Formed Using The Data From The Meteorological Department. Slope Map From SRTM And By Using Topographical Map Of The Area.

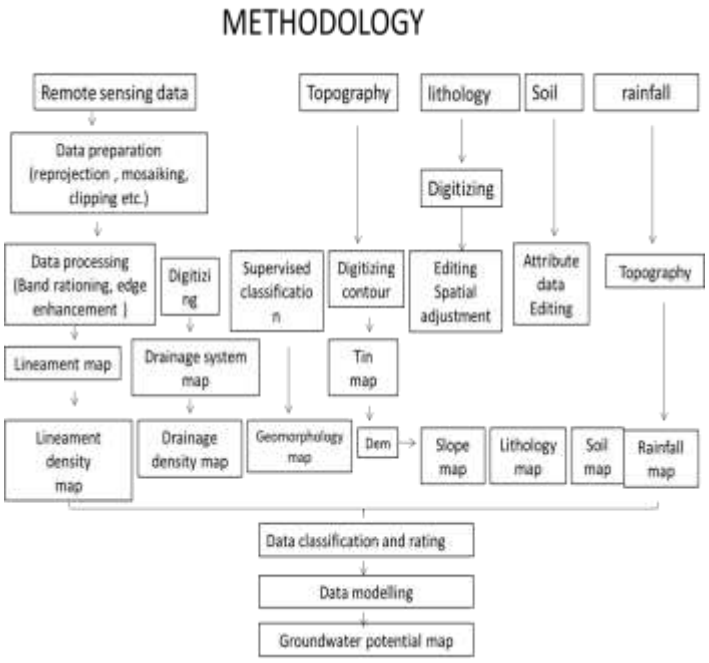

Figure 1: Flow Chart Of Methodology For Groundwater Potential Zonation

A. Lithological Map

Lithology Is A Very Important Criterion To Find Out Groundwater Potential Zone. By Identifying The Spectral Arrangement Of Tone And Texture From A Remote Sensing Image One Can Extract The Geological Information. (Arkoprovo Et Al., 2012)). Lithological Maps Can Be Generated By Digitizing The Remote Sensing Image Along With The Data From The Field. It Is The Major Factor That Controls The Occurrence Of Groundwater And Its Transportation For One Place To Another. Lithology Of The Area Provides A Channel For The Flow Of Groundwater And Provides Storage Space For Groundwater.

B. Geomorphological Map

Geomorphology Exercises Significant Control Over The Groundwater Regime ((Mohanty & Behera, 2010)). The Integrated Study Of Geology And Geomorphology Plays A Vital Role In Understanding The Occurrence Of Porous And Permeable Zones. The Geomorphological Map Has To Be Prepared By Visual Interpretation Of Satellite Data

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On The Desired Scale (1:50000) Using The Photogeological Elements Viz. Tone, Texture, Shape, Size, Association Etc. We Can Demarcate The Various Geomorphological Features.

C. Slope Map

Slope Is A Major Factor That Controls The Runoff And Infiltration Of Rainwater ((Ravi Shankar & Mohan, 2005)). Topography Relates To The Local And Gives Us An Idea About Groundwater Flow Direction ((Gupta & Srivastava, 2010)). Slope Of The Area Definitely Plays A Vital Role In Groundwater Potential Mappingand It Can Be Generated Using A Survey Of India Topo Sheet And SRTM Data Of The Area. In Relation To Groundwater Flat Areas Having A Greater Chance To Hold Rainfall, Which In Turn Allowing It To Infiltrate More, Whereas In Areas Having High Slope There Will Be More Runoff And Infiltration Will Also Be Less.

D. Drainage Density Map

Drainage Density Means The Closeness Of Stream Channels, Thus Provides A Quantitative Measure Of The Length Of The Stream Within A Square Grid Of The Area ((Mohanty & Behera, 2010)). The Subsurface Hydrogeology Of The Area Is Restricted To The Drainage Characteristics Of The Basin Using This One Can Find Out The Groundwater Condition ((Pradhan, 2009)). Drainage Density Map Can Be Produced Using A Drainage Map, In This Density Map The Values Can Be Assigned Based On The Density Of Drainage Pattern. Higher The Drainage Density Lesser The Infiltration Capacity I.E., Low Void Ratio Leads To The Lesser Groundwater Potentiality And Lesser The Drainage Density Higher The Infiltration Capacity Leads To The Higher Groundwater Potentiality ((Jose, Jayasree, Santhosh Kumar, & Rajendran, 2012)).

E. Lineament Density

Lineaments Are Linear Surface Features That Are Distinctly Different From The Patterns Of Adjacent Features And Presumably Reflect Subsurface Phenomena ((Jose Et Al., 2012)). The Lineament Density Map Indirectly Reveals The Groundwater Potentiality Of An Area, Since The Presence Of Lineaments Usually Denotes A High Porocity And Permeability. Areas Having High Density Of Lineament Forms Good Source For Groundwater Development. Lineament Density Map Of The Area Can Be Prepared Using Satellite Data And Its Interpretation Along With The Field Data. From The Lineament Map, We Can Generate The Lineament Density Map. The Area Having High Lineament Density Will Have High Groundwater Potentiality And The Area Having Low Lineament Density Will Have The Low Potentiality To Groundwater.

F. Hydrogeological Map

Water Bearing Capacity Of Different Rock Formation Plays A Vital Role In The Movement And Occurrence Of Groundwater. The Hydrogeological Map Of The Area Can Be Generated Using Field Data (Pre And Post-Monsoon Water Table Data). The Water Table Map Depicts The Spatial Pattern Of Groundwater.

G. Rainfall Map

Occurrence Of Groundwater Is Controlled By The Amount Of Rainfall, As Higher The Rainfall Higher The Chance To Get Infiltrate And Lesser The Rainfall Lesser The Chance To Infiltrate. Rainfall Is The Only Source Of Groundwater. The Rainfall Map Of Any Area Can Be Generated Using The Rainfall Data From The Meteorological Department.

H. Modeling In GIS

All The Thematic Maps I.E. Geology, Geomorphology, Drainage Density, Lineament Density, Slope, Hydrogeology, Rainfall Are Assigned Weight And Ranks According To Their Influence On Groundwater Occurrences. And Then Modeling Can Be Done Using The Weight Overlay Index Method In GIS. On The Basis Of Groundwater Modeling In GIS The Area Can Be Classified Into Following Very High, High, Moderate, Poor And Very Poor.

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GPM = (Lw×Lr) + (Gw×Gr) + (Sw×Sr) + (Ldw×Ldr) + (Dw×Dr) + (Ew×Er) + (Slw×Slr) + (Rw×Rr)

(Muheed M. Awadhesh Et. Al 2009)

Where,
L =Lithology
G =Geomorphology
S = Soil
Ld =Lineament Density
D =Drainage Density
Sl =Slope
R =Rainfall
E= Elevation

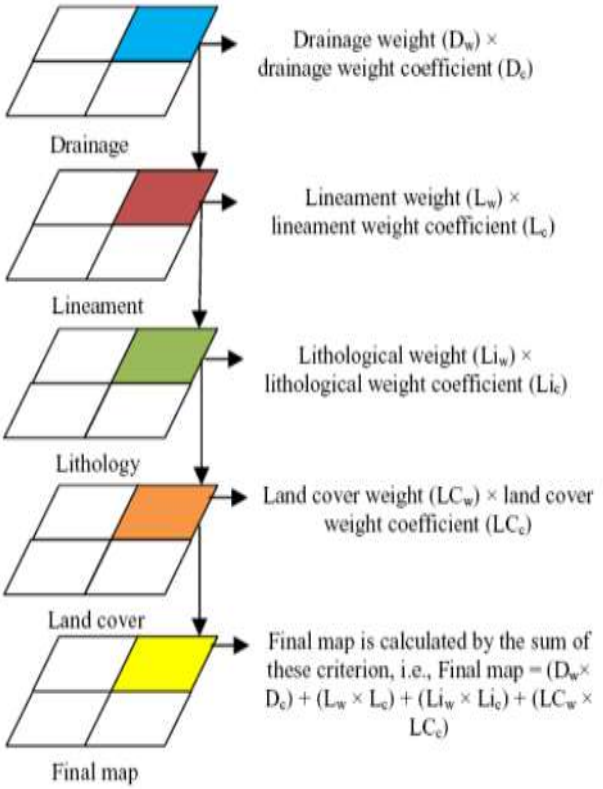

Figure 2: Modeling In GIS By Assigning Weight And Rank (M.I. ADHAM Et. Al. 2010)

IV. RESULT AND DISCUSSION

The Groundwater Potential Zone Can Be Generated Using Remote Sensing And GIS By Making Thematic Maps Of Geology, Geomorphology, Drainage Density, Lineament Density, Slope, Hydrogeology, And Rainfall And By Assigning Weight (A Weight Represents The Relative Importance Of The Parameters In Relation To The Objective Of The Study) And Rank To Them According To Their Influence On Groundwater. After Assigning Weight And Rank Modeling Is Done In GIS Using The Weight Index Overlay Method (Weighted Overlay Analysis Is A Simple And Straightforward Method For A Combined Analysis Of Multiclass Maps) To Get The Final Groundwater Potential Map Of The Area.

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