Tree species as indicators of ground water recharge and discharge

Rinku Verma, Jayanti T, Vinoda S, Shivappa, A.N.S. Gowda

Abstract— **A study was carried out to check the aquifer potential points using geophysical survey at the campus of College of Sericulture, Chintamani located in the Agro-climatic zone-5 of Karnataka, India. The study area receives an average annual rainfall of about 688 mm per annum. The survey becomes challenging to get the right aquifer point on account of the dykes in the region. The geophysical survey was carried out at 2 spots in the total area of nearly 200 acres of the campus. Interestingly, the survey recorded specific tree species located in the region close to the existing and yielding aquifer points. The identified tree species in the entire study area were taxonomically grouped. Soil analysis was carried out to study soil characteristics such as moisture content, pH, electrical conductivity, bulk density, particle density, maximum water holding capacity, pore space and volume expansion of soil. The effect of presence of various tree species and the relevant soil characteristics on the availability of water was linked. Species were studied from Chintamani to Kolar and Chintamani to Bangalore and surrounding villages of Kolar district. The study recorded a few families of tree species occurring as water indicators and the others present near to water bodies hence concluding that planting specific tree species may help in the conservation and infiltration of the groundwater in arid regions and the presence of such species also suggest ground water discharge areas and presence of such species indicate water.**

Index Terms— **Electrical resistivity, ground water, tree species, rainfall.**

I. INTRODUCTION

In times of water crisis preservation of water resources are a must. Be it surface or underground. In India some regions are drought prone and hence depend on underground water for agriculture or other activities. Ground water also called zone of saturation, water table or capillary fringe is used by plants that habitually grow by perpetuating their roots to these zones to obtain water. The eco-hydrological indicators can suggest groundwater discharge areas, the depth to groundwater and the degree of mineralization that can be realized by applying eco-hydrological groundwater indicator species to groundwater conceptual models. With a few exceptions, the greatest depth from which ground water is known to be lifted by plants is about 50 feet. For persons in distress clues of different ground water plants and their approximate depth are of considerable practical value.

Plant species become dormant after ground water is beyond their reach. Other species growing near ground water within reach continue to grow actively throughout summer. Certain species in arid regions are observed to the depth of water table, showing that these species are confined almost completely to areas with specific depth limits. Others show no relation to water table and may grow where the water table is at a great depth or where ground water is entirely absent (Kearney 1914a, 1914b). Trees and plants afford invaluable assistance in locating successful wells, position of master joints or belts of fissured or decomposed rocks, along which underground water percolates, being not infrequently indicated at the surface by lines of trees or shrubs, known as “aars.” One of the most reliable indicators of the existence of water well such aars is the Acacia horrida (sweet thorn). Acanthoslcyos horrida is the best indicator (narr bush) (Wagner, 1916). Water level in soils and its importance to note the depth of this level beneath the surface," and that "the depth of the water level helps to determine plant societies (Coulter 1900).

Mesquite is mentioned as an indicator of ground water where it occurs at depths of a few yards, and alkali sacaton (Sporobolus airoides) and other plants as indicators where it occurs at depths of only a few feet (Coville 1893). Distinct from these is the screw bean or screw-pod mesquite (Prosopis odorata or P. pubescens) classified as Stromboc (paodorata or pubescens) (Cannon, 1911). The Salton Sea region of California the so called "running mesquite” (Prosopis juliflora) is considered more reliable as an indicator of ground water than the crew bean. Water can usually be obtained at slight depths where mesquite is growing. Mesquite may depend either on ground water or on the water from periodical flooding, and that where its growth is due to ground water, the water may lie within a few feet of the surface or be as much as 50 feet below was investigated just west of Tucson (Mendenhall 1927).

Plants as indicators of groundwater, with reference to Acacia constricta as a conspicuous representative has been worked (Meinzer, 1927). Its habits are essentially those of the mesquite as to water requirements, and it closely resembles this species in its xerophytic structure. Acacia greggii grows with the mesquite. The mesquite and Acacia constricta have tenaciously held their places through all vicissitudes and promise to be dominant in their habitat until actually rooted out, [Cannon, 1911). Mesquite, wherever the depth to water is not more than 25 to 30 ft and it generally considered to indicate that ground water is within that distance of the surface.

Two species of willow, Salix gooddingii and Salix fluvwtttis, are referred to as ground-water plants. Sycamore trees

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indicate the presence of ground water in many localities in the arid regions. Both cottonwood and mesquite roots are highly developed below the water table, and roots of alfalfa extending somewhat below the water table [9]. The water table everywhere fluctuates. In most places within the areas occupied by ground-water plants the seasonal fluctuation amounts to 2 or 3 feet and in some places it is as much as 25 to 50 feet. This fluctuation is probably beneficial because on the whole it produces a thicker belt of aerated soil that is moistened by ground water. The study has made use of potential and usefulness of ecohydrological groundwater indicators to the hydrogeological community along with soil studies in arid regions.

The study also indicates specific tree species identified to their respective families near existing potential ground water regions, yielding ground water for drinking purpose. These regions indicate specific trees as well as trees growing close to well and inside water bodies. Tree species and soil quality have been linked with existing bore wells and well regions in the study area.

II. Material and Methods

Chintamani is located in Karnataka, India about 74 kms from Bengaluru and the College of Sericulture (COS) is about 7 kms from Chintamani town. A survey was carried out at the College of Sericulture in two different plots of 5 acre each (10 acres). A complete Geophysical survey of this area was carried out using electrical resistivity instrument and the existing flora and identification of tree species to their respective families documented. The probable aquifer points were located using geophysical survey by performing electrical resistivity values obtained in the field for both the plots. The identified tree species have been planted by the college in 1990's. The existing species is given in Table III, with the list of all the identified species in 10 acres plot. The number of tree species present has also been indicated. The area near to the yielding aquifer (existing bore) and the other regions were studied for the tree species prevalent in the region. Specific families of tree species present near ground water zones were identified and recorded. Apart from these two important surveys, the soil samples were carried from the aquifer identified spots using geophysical survey and the other sampled point, where the electrical resistivity was recorded.

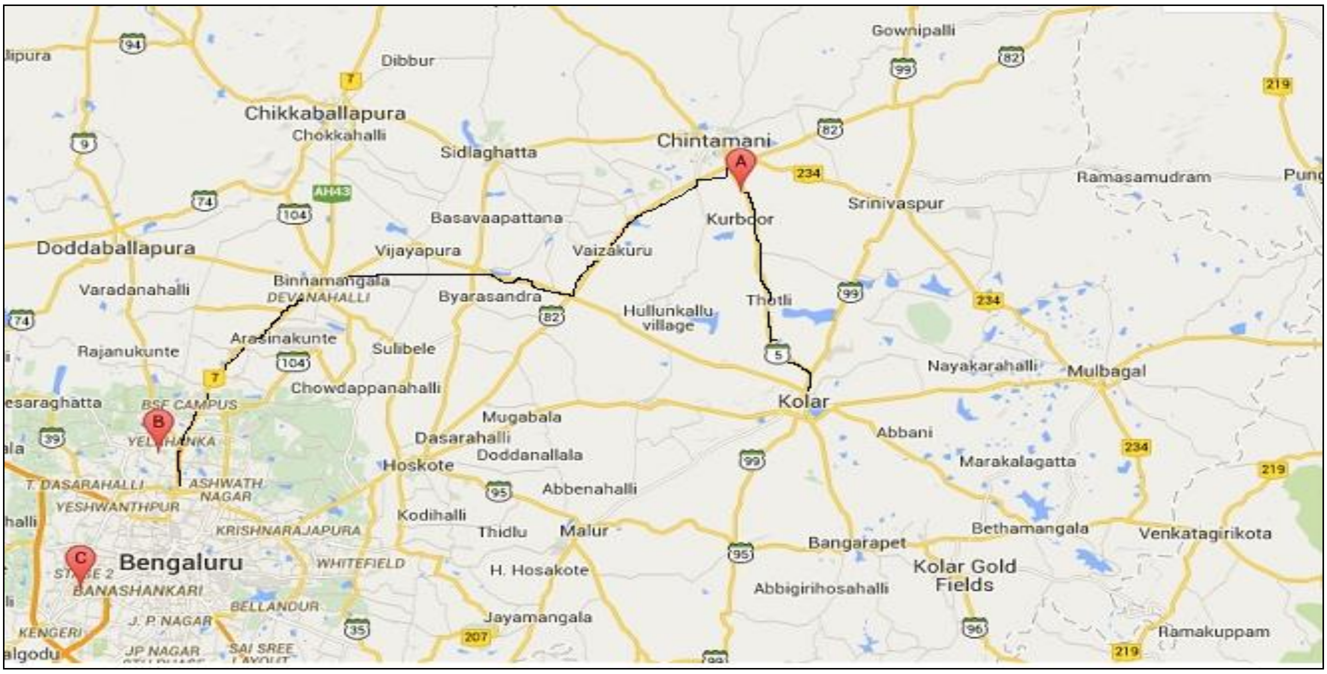

Figure 1. Location of the College of Sericulture at Kurboor, Chintamani. Chintamani (A) to Kolar, Chintamani to Devanahalli, Bengaluru to International Airport.

The soil samples were analysed for moisture content, pH, electrical conductivity, bulk density, particle density, maximum water holding capacity, pore space and volume expansion of soil. Soil analysis was carried out to give the status of the soil type existing in the given location (aquifer and non-aquifer points).

Soil samples were taken from both the 5 acre plots. In the first 5 acre plots about 4 sampling locations were identified. One near the existing bore well, one near the open well, other from region showing high electrical resistivity. The last point was close to the soak pit region. In the second 5 acre plot, the soil samples were collected from 3 failed bore well points and 1 from existing and yielding aquifer.

Keen's cup experiment for the determination of bulk density, particle density, maximum water holding capacity, percentage pore space and volume of expansion were carried out using standard procedures. The other parameters analysed included pH, conductivity and moisture content.

The field survey was also carried out from College of Sericulture (COS) heading towards Kolar including villages in and around Chintamani and Kolar. An attempt is also made to identify trees species existing near bore well point/tanks of some of the villages surrounding Chintamani, Kolar regions. The other field survey was carried out on the way to Bangalore via H cross and Devanahalli including few villages and finally from Bangalore up till the International Airport, (Fig, 1) Bangalore for tree identification near bores and existing ponds and water bodies. This data gives a complete picture of the existing tree species of the regions into their respective family. Details of rainfall trend have been listed in the table over the last few years from (2004 to 2013).

III. Results

In the first plot of 5 acres the trees identified as per the following families has been listed in the Table I. The region surrounded by specific trees showed a very low electrical resistivity in comparison to the other regions which indicated higher electrical resistivity above 200 ohms showing trees of different families. The tree species identified were Jamun (Myrtaceae) and Fern tree (Sapindaceae) in large number as well as mulberry (Moraceae) plants on the other side. The density of Jamun was maximum in the 1st five acre plot, these regions indicated high electrical resistivity values. The total number of trees observed and recorded in this region was about 40 Jamun trees. Jamun is a drought tolerant tree. Sources of ground water identification can be made using tree indicator species. Areas having tree population on its 2 to 3 sides prove to be useful for locating the points using hydrogeological survey, electrical resistivity. On the other 5 acre plot the following trees (Table II) were located near regions, which once yielded ground water from confined aquifer and unconfined aquifer had stopped yielding (450ft and 800ft respectively).

Table I. Tree species located near existing aquifer point and remaining in the first five acres of land.

Family	Number of Species	Name of the tree species	Water Indicator Species
Near yielding bore			
Caesalpinaceae Leguminaceae	7	Camel foot tree (few) Cassia spp (24) Pongamia (18) Subabul (4) Acacia mangium Acacia spp (2) Albizia lebbeck (3)	Referred to as Indicators from literature Seen near water
Fabaceae	2	Tamarind (10) Gulmohar	Referred to as Indicators from literature Few near water
Santalaceae	1	Sandal (16)	Few near water
The remaining portion of the area under survey			
Leguminaceae	3	Pongamia (18) Acacia auriculiformis (20) Acacia (20)	
Amaryllidaceae	1	Agave (6)	
Myrtaceae	2	Eucalyptus (2) Jamun (62)	
Moraceae	2	Fig Mulberry (20)	Away from water Near the well (unconfined aquifer)
Sapindaceae	1	Fern tree (24)	No water/ rock area
Meliaceae	2	Mahogany (3) (24) Neem (40)	Few near water (well)
Euphorbiaceae	3	Tapioca (20) Jatropa (3) Amla	
Moringaceae	1	Drumstick (3)	
Poaceae	1	Bamboo (20)	
Sapotaceae	1	Madhuca longifolia (20)	
	1	Hippae (3)	
Combretaceae	4	Terminalia tomentosa (1) Terminalia catappa (25) Indian almond Terminalia arjuna (1)	
Verbenaceae	2	Casuarina equisetifolia Teak (2)	
Magnoliaceae	1	Michelia champaka	
Apocynaceae	1	Temple tree (2)	
	1	Baghe mara	

Table II. Lists of tree species identified in the second five acre plot and near existing bore

Family	Number of species	Number of Species	Water Indicator Species
Meliaceae	3	Mahogeny (3) Melia duba (3) Neem (47)	Water indicator species
Leguminaceae / Fabaceae	5	Acacia mendium (20) Acacia auriculiformis (20) Subabul Tamarind (10) Dalbergia (20)	Near to the water region/ Few near water
Malvaceae	1	Simaroba (22)	-
Proteaceae (Silver oak family)	1	Grevillea robusta (20)	-
Verbenaceae	1	Teak (13)	
Poaceae	2	Napier grass 2/ Bamboo (few)	-
Sapotaceae	1	Mohwa (1)	-
Anacardiaceae	2	Cashew (4) Mango (17)	-
Malvaceae	1	Thespesia (20)	-
Palmae	1	Coconut (4)	-
Annonaceae	1	Ashoka (12)	-
Pinnaceae	1	Christmas tree (2)	-
Tiliaceae	1	Cherry (1)	-
Moringaceae	1	Drumstick (5)	-
Myritaceae	3	Jamun (4), Eucaylptus (70), Guava (5)	-
	Near yielding bore		
Fabaceae	1	Tamarind (1)	
Moraceae	1	Jack fruit	
Euphorbiaceae	1	Amla (1)	
Rutaceae	1	Aegel marmalos (1)	
Magnoliaceae	1	Champaka (3)	
Bignoniaceae	1	Spathodia (3)	
Tiliaceae	1	Japanese cherry	
Proteaceae	1	Silver oak (22)	
Coniferae	1	Tuja (4)	
Sapindaceae	1	Leechi (1)	
Rutaceae	1	Lemon tree (2)	

The other side had bore points where water is being utilized. Electrical resistivity recorded lower values in regions which once had ground water availability and yielding bores. On the same plot the other regions had higher values.

A complete list of the species growing has been indicated in Table III, giving complete taxonomical details including common name, botanical name assigned to their respective family.

Soil analysis data reveals: Irrespective of the study carried out in the two locations, the soil characteristics/properties are all within the permissible limits. The quality of soil is within limit and possesses no adverse effect on the plant vegetation form an agricultural point of view. Bulk density recorded was 1.14 g/cc for the first plot, while the ground water is utilized for drinking with an electrical resistivity of 53 ohms. The same sampling location showed values of maximum water holding capacity (MWHC) being 34%, pore space 39.9% and volume expansion of soil 15.50% respectively (Table, IV). These values were observed to be higher as compared to the other soils where the bulk density was slightly lower suggesting higher rain water infiltration rates. Thus leading to more of recharge and discharge, the tree species present in this region included Leguminaceae and Casesalpinaceae.

In the same plot the other soil sampled area showed high electrical resistivity zone (200 ohms), higher bulk density values of 1.41 and MWHC of 18%, pore space of 26.7% and volume expansion of soil 3.46%. The geophysical survey shows, the region has underground rocks and dykes, the soil analysis too, clearly points out low water infiltration rates as compared to the previous soil analyzed area providing sufficient drinking water. At points outside the surveyed areas dykes were seen near the rocky pond. Two strips of dykes running parallel to each other were noticed.

In the second plot studied, a volume expansion study is comparatively lesser than the soils analyzed from the previous plot where ground water is utilized for drinking. The soil is able to hold water but as there is presence of rocks / dykes the water is not able to sustain (for longer availability) at that point and may lead to the possibility of flow in spaces available away from the dyke.

Rainfall data from 2004 till date shows that there was a gradual increase, but sudden decrease has been observed from 2012 onward. In 2014 rainfall has been recorded below normal (Fig.2)

Table III, Plant species identified in the complete 10 acre plot.

CN: African Tulip Tree BN: *Spathodia companulata* F: Bignoniaceae	CN: Mango BN: *Mangifera indica* F: Anacardiaceae	CN: Rose Apple BN: *Syzygium jambos* F: Myrtaceae	CN: Custard Apple BN: *Annona squamosa* F: Annonaceae	CN: Hebbevu BN: *Melia dubia* F: Meliaceae	CN: Agati BN: *Sesbania grandiflora* F: Leguminaceae
CN: Champaka BN: *Michelia champaka* F: Magnoliaceae	CN: Cashew BN: *Anacardium occidentale* F: Anacardiaceae	CN: Jamun Tree BN: *Syzygium cumini* F: Myrtaceae	CN: Lantana BN: *Lantana camara* F: Verbenaceae	CN: Sisso (Sisham) BN: *Dalbergia sisso* F: Fabaceae	CN: Rubber Tree BN: *Ficus elastica* F: Moraceae
CN: Neem Tree BN: *Azadirechta indica* F: Meliaceae	CN: Sandal BN: *Santalum album* F: Santalaceae	CN: Indian almond BN: *Terminalia catappa* F: Combretaceae	CN: Terminalia (Asian) BN: *Terminalia tomentosa* F: Combretaceae	CN: Banyan Tree BN: *Ficus bengalensis* F: Moraceae	CN: Christmas Tree BN: *Araucaria cooki* F: Pinnaceae
CN: Camel Foot Tree BN: *Bauhinia purpurea* F: Caesalpinaceae	CN: Opuntia BN: *Opuntia microdasys* F: Cactaceae	CN: Indian tulip BN: *Thespesia populnea* F: Malvaceae	CN: Terminalia BN: *Terminalia arjuna* F: Combretaceae	CN: Bael BN: *Aegle marmelos* F: Rutaceae	CN: Guava BN: *Psidium guajava* F: Myrtaceae
CN: Silver Oak BN: *Greviliea robusta* F: Proteaceae	CN: Fern Tree BN: *Felicium decipiens* F: Sapindaceae	CN: Gliricidia BN: *Gliricidia sepium* F: Fabaceae	CN: Mahua BN: *Madhuca longifolia* F: Sapotaceae	CN: Drumstick BN: *Moringa oleifera* F: Moringaceae	CN: Sapota BN: *Achras sapota* F: Sapotaceae
CN: Eucalyptus Tree BN: *Eucalyptus grandis* F: Myrtaceae	CN: Amla BN: *Emblica officinalis* F: Euphorbiaceae	CN: Mahogany BN: *Swietenia mahogani* F: Meliaceae	CN: Teak BN: *Tectona grandis* F: Verbenaceae	CN: Cassia BN: *Cassia fistula* F: Caesalpinaceae	CN: Acacia BN: *Acacia auriculiformis* F: Leguminaceae
CN: Pongamia BN: *Pongamia pinnata* F: Leguminaceae	CN: Subabul BN: *Leucaena leucocephala* F: Leguminaceae	CN: Lebbeck BN: *Albizia lebbeck* F: Fabaceae	CN: Honne /Indian kino tree BN: *Pterocarspus marsupium* F: Meliaceae	CN: Simaruba BN: *Simaruba glauca* F: Malvaceae	CN: Manjium Tree BN: *Acacia manjium* F: Leguminaceae
CN: Agave BN: *Agave americana* F: Amaryllidaceae	CN: Gulmohar BN: *Delonix regia* F: Fabaceae	CN: Temple Tree BN: *Plumeria alba* F: Apocynaceae	CN: Casuarina BN: *Casuarina equisetifolia* F: Casuarinaceae	CN: Acacia /Kari Jaali BN: *Acacia nilotica* F: Leguminaceae	CN: Peacock Flower BN: *Caesalpinia pulcherrima* F: Caesalpiniaceae
CN: Tamarind BN: *Tamarindus indica* F: Fabaceae	CN: Jack Fruit BN: *Artocarpus heterophyllus* F: Moraceae	CN: Japanese Cherry BN: *Muntingia calabura* F: Tiliaceae	CN: Peepal Tree BN: *Ficus religiosa* F: Moraceae	CN: Ashoka BN: *Polyalthia longifolia* F: Annonaceae	CN: Confiderate Rose /Chinese rose BN: *Hibiscus mutabilis* F: Malvaceae
CN: Bamboo BN: *Bambusa vulgaris* F: Poaceae	CN: Fig BN: *Ficus carica* F: Moraceae	CN: Tapioca BN: *Manihot esculenta* F: Euphorbiaceae	CN: Indian Cork Tree BN: *Millingtonia hortensis* F: Bignoniaceae	CN: Mulberry BN: *Morus alba* F: Moraceae	CN: Golden cane palm BN: *Chrysalidocarpus lutescens* F: Palmae
CN: Coconut BN: *Cocos nucifera* F: Palmae			*CN: Common Name *BN: Botanical Name *F: Family		

Table IV. Soil characteristics study of the selected regions

Table IV. Soil characteristics study of the selected regions during the electrical resistivity survey.

Si No	Sample location	Site characteristics	Electrical resistivity values (ohm)	pH	Conductivity (dS/m)	Moisture content (%)	Bulk density (g/cc)	Particle density (g/cc)	MWHC (%)	Pore space (%)	Volume expansion of Soil in (%)
	First 5 acre location (College of Sericulture, Chintamani)										
1 I	Near high ER (Fern trees)/ dyke	Rock below, no water	200 ohms	6.26	0.21	9.94	1.47	2.1	18	26.7	3.46
2 I	Existing bore low ER	2 inches water from existing bore	53 ohms	6.7	0.326	9.98	1.14	1.91	34	39.9	14.5
3 I	Near existing well	Water Filled	Lower ER value	7.19	0.324	10.01	1.2	2.2	30.4	37.6	12.16
4 I	Existing waste water collection pit	Waste water collection	Lower ER value	6.76	0.226	9.94	1.33	2.06	23.1	30.7	8.04
	Second 5 acre location (Krishi Vigyan Kendra and Farm, College of Sericulture, Chintamani)										
1II	Near failed bore point/ dykes present	No water	Higher ER values	6.53	0.172	9.95	1.25	2.06	25	30.4	4.09
2II	Near suggested bore point	Vegetation around	63 ohms	6.12	0.209	9.92	1.04	1.7	37.3	38.8	8.93
3II	Near failed bore	Vegetation seen	Higher ER value	7.71	0.409	9.97	1.4	4.13	24	35	10.82
4II	Near operational bore	1 and half inches of bore water	Lower ER value	6.01	0.42	9.91	1.4	1.95	20	28	3.72

*ER – Electrical Resistivity carried out using electrical resistivity equipment

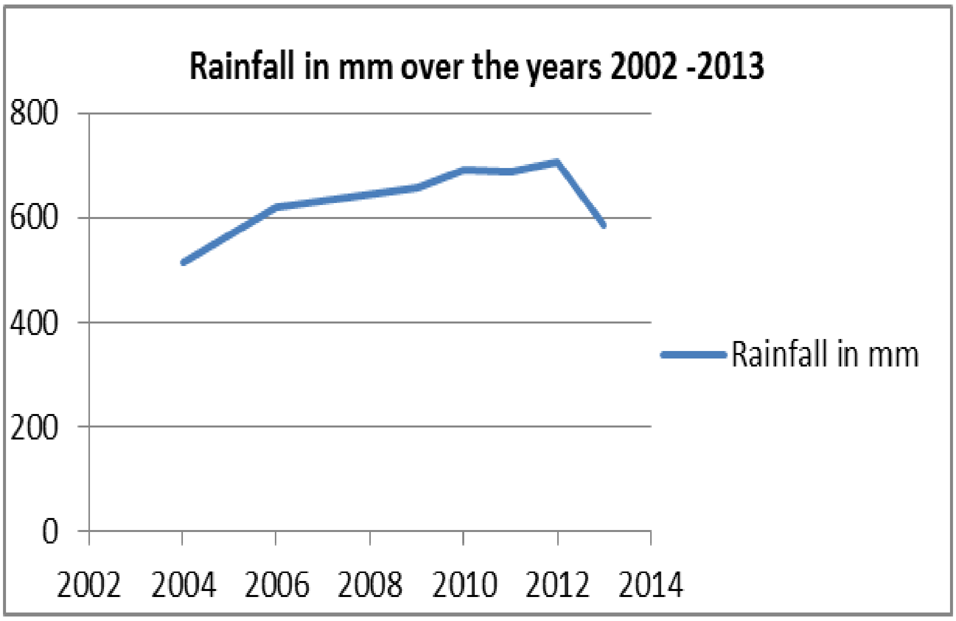

Fig 2. Rainfall data of a decade from 2002 till 2013 at College of Sericulture/Chintamani, Karnataka, India.

Table V. List of villages and tree species seen in the 9 villages (Karnataka).

Si No	Names of village	Tree Species	Near Borewell	Near Pond
1	*Chintamani, College of Sericuture, (1st 5 acres)*	*Cassia, Camel foot tree, Acacia, Albizia spp, Tamarind, Gulmohar, Pongamia, Subabul, Sandal*	*Near bore*	
2	*Chintamani, College of Sericuture, (2nd 5 acres)*	*Mahogeny, Melia dubia, Neem, Subabul, Acacia mangium,* *A. auriculiformis Tamarind, Dalbergia*	*Near bore*	
1	Chintamani, Munagana - halli	Neem, Pongamia, Euclaptus, Tamarind, Acacia (*Acacia nilotica*, *Acacia arjuna*), Jack fruit & Coconut.	-	-
2	Kaiwara, Paramacha-nahalli, Chintamani	Neem, *Melia duba*, Coconut, Tamarind, Pongamia, Teak, Eucalyptus, Cashew, Jamun, Jatropa, Thespesia, Mango, Guava & Sopata.	Jamun, Tamarind Conconut, Teak People tree	-
3	Konappalli	Tamarind, Euclaptus, *Melia duba*, Coconut, Pongamia, *Prosopis juliflora*	*Prosopis juliflora* Acacia spp	-
4	Yadahalli	Eucalyptus, Tamarind, Pongamia, Silver Oak, Neem, Banyan tree, People tree & Subabul	Jamun, Jack, Pongamia, Coconut, mulberry	-
5	Sugatur	People tree, Neem, Pongamia, Eucalyptus, Silver oak, Teak, Subabul, & Fig (wild)	-	-
6	Dinnehosa-halli	People tree, Silver oak, Pongamia, Teak, Tamarind, & Eucalyptus	-	-
7	Madderi	Silver oak, Eucalyptus, Pongamia, Neem, Subabul & Teak	-	-
8	Ammanallur (towards Bangalore)	Acacia spp & Pongamia (Leguminaceae)	-	sited near
9	Ponds between college of Sericulture and Kolar	Acacia, Pongamia & Tamarind (Leguminaceae)	-	sited near pond
10	Sited in another 20 villages towards Bangalore via H- Cross	*Acacia arabica*, few other Acacia spp, Few Pongamia, very few Tamarinds. One pond had *Dalbergia sissoo* surrounding (Leguminaceae)	-	near bore and sited near pond
11	Sited outskirts of Bangalore heading toward Internation-al Airport (7 sites)	*Acacia arabica*. *Acacia auriculiformi*, Copper pod / *Peltophorum pterocarpum* (Leguminaceae)	-	sited near pond

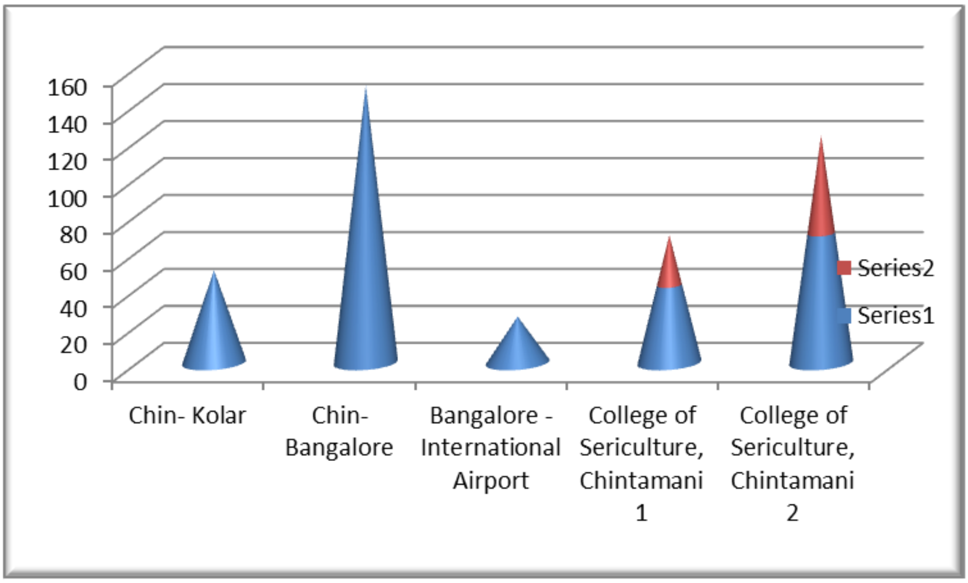

Fig. 3. Indicates the presence of two families seen in the various sites
***Series 1 Leguminaceae and Series 2 Caesalpinaceae**

The ponds present between Farm, College of Sericulture and outskirts of Chintamani had Acacia spp and Pongamia spp present near/close to the ponds. The similar situation was

observed in all the ponds seen heading towards Kolar. Acacia species identified belonged to *A. nilotica* and *A. arabica*.
Maximum occurrence of the species in these regions included those belonging to family Leguminaceae, Casesalpinaceae, Meliaceae, Proteaceae and Santalaceae were predominant in the Agroclimatic zone 5, College of Sericuture. Leguminaceae, *Caesalpinaceae*, and Meliaceae have been reported to indicate water rather they are the water indicating species in the studied plots. Through the *mesquite "Prosopis juliflora of family* Fabaceae *was not recorded in the 10 acre plot, the species was identified in the villages found outside the sampling area rather on the outside plots. The village* Konappalli, close to Chintamani indicated water availability above 600ft with presence of *P. juliflora* species (Table,V).
Fig. 3, shows that maximum occurrence of family Leguminaceae predominating in the semi-arid region of Karnataka, India, referred to as water indicators as well as its presence near bores and tanks.

IV. DISCUSSION

This study may aid to find out plants which may act as indicators of ground water and better recharge points, thereby increasing recharge efficiency. Families of plant species occurring near water regions have been identified belonging to Leguminaceae, *Caesalpinaceae* and Meliaceae in the studied plot of 10 acres at Agroclimatic zone 5, at College of Sericulture, Chintamani, Karnataka. These regions also had lower electrical resistivity values. The tree species from first plot were not prevalent in regions having higher electrical resistivity values when hydrogeological studies were carried out in the surveyed plots. The average depth of bore well was below 1200ft. The region has presence of dykes passing at various points under study.
Soil analysis reveals more recharge in the regions which had predominant tree species present in this region like Leguminaceae & Casesalpinaceae. Further research study is very essential in these lines; the literature availability on these lines is very much limited. High porosity was recorded in the 1st five acre plot in water yielding regions with lower bulk density. In an earlier study *Acacia nilotica* and *Casuarina equisetifolia* had higher influence on the bio-physical properties such as porosity, infiltration rate, hydraulic conductivity and aggregate stability improved under different tree covers, while, bulk density and erodibility of soil decreased (Nandagoudar etal 1997).

The species *Prosopis juliflora* has been identified in one of the villages (Konappalli, Chintamani, Karnataka, India) and the depth of the bore recorded in this village ranged from 450 to 600ft and all were water yielding bores & wells as this belt is famous for vegetable cultivation, thus providing enough water to the village. *Acacia nilotica*, *Dalbergia sissoo* & *Prosopis juliflora* are some of the trees which are also used for soil improvements (Virendra et al., 2011). In another study *A. nilotica D. sissoo*, and *P. juliflora* were studied for root penetrations. *P. juliflora* showed maximum root spread followed by *A. nilotica* and *D. sissoo*. All these species had maximum distribution of root biomass. Deep roots tend to improve the rates of percolation of water from upper soil horizons into lower substrates (Virendra et al., 2011).

Plant species need to be selected that relatively indicate locations of ground water discharge. Species with a high validity are those that grow only in ground water discharge areas (Goslee et al 1997). Species can maintain themselves in drought.On the other hand are the phreatophytes, or well plants, which habitually grow where they can send their roots down to the water table, or to the capillary fringe immediately overlying the water table; thus, they are able to obtain a perennial and secure supply of water (Meinzer, 1972).
Plants with deep roots that are able to tap into deep soil moisture or groundwater may show little moisture stress compared with shallow rooted species (Midgley and Bosenberg, 1990).
Indigenous tree and shrub genera that often have deep roots include Acacia, Boschia, Olea, and Rhus and exotics include Eucalyptus (Myrtaceae) and Prosopis (Leguminaceae). The structure of the woody tissues of plants that are tolerant of water shortages or water-stress differ from those that are not (Tyree and Sperry, 1989, Tyree and Ewers, 1991, Jarbeau et al., 1995). This is particularly true of phreatophytic species and of tap and sinker roots which are specialized for conducting large quantities of water (Pate et al., 1995). Outside the study area in a survey made towards Kolar and Bangalore, the characteristic tree species prevalent near bores and ponds included Acacia species, *A. nilotica*, Pongamia spp and very few Tamarind trees, most of them belonging to the family Leguminaceae. *A. arabica* & *A. nilotica* commonly grows close to waterways on secondary flooded river flats and tolerates salinity well. It also grows in areas receiving less than 350 mm of rainfall to 1500 mm per annum. Many of *A. arabica* plantings were recorded among bore drains, long open drains distributing artesian water (Gupta, 1970). In dry areas, presence of *A. karroo* indicates the sign of water, both above and underground (Barnes et al., 1996). Preservation of the tree species is very essential as urbanization has led to their loss including destroying species which act as ground water indicators, rechargers and dischargers. Identification of the species belonging to family Leguminaceae *and Caesalpinaceae* are regarded as good ground water indicators and may suggest ground water discharge sites. It has been reported that, deep roots tend to improve the rates of percolation of water from upper soil horizons into lower substrates. Cassia was found to be better than Gliricidia and Grevillea in reducing both soil and water runoff losses (Omoro and Nair 1993). Our study clearly points out species like Leguminaceae and Cesalpinaceae have deeper roots hence better the rate of percolation and discharge of rain water there by helping in maintaining of the water table. Thus Leguminaceae and Cesalpinaceae are referred to as water indicators tree families. Acacia, Cassia, Neem, Tamarind and Albizia are spotted near bores in this study and the others *Acacia nilotica*, *A. arabica* and *P. juliflora* are sotted in the villages close to water bodies and routes under the study (Chintamani, Kolar and moving towards Bangalore, via H – cross, Karnatka, India in the semiarid regions).
Trees act as discharge points as may be evident from soil analysis data and low electrical resistivity values. Right step in ground water conservation would also include the right tree species planting and right family leading to the management of ground water table in these ecologically water stressed regions.

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