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Seasonal And Morphological Analysis Of Airborne PM_{10} And $PM_{2.5}$ In Srinagar Garhwal (Himalaya Region)

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To understand the morphology and chemical constituent of ambient air in Srinagar, Garhwal valley, an experiment was carried out in the Department of Physics, Chauras campus, Hemwati Nandan Bahuguna Garhwal University. The particulate matter (PMs) were collected by using fine particulate dust sampler (APM 550 and APM 460 NL, Envirotech, New Delhi) and analysed by using SEM and EDAX technique (CARL ZEISS, MA15/EVO18). The average mass concentration of PM_{10} is recorded as 107.4 ± 16.3 $\mu g/m^3$, whereas the average mass concentration of $PM_{2.5}$ is recorded as 88.48 ± 14.74 $\mu g/m^3$ which are much higher than the standard value prescribed by WHO and NAAQS. The reason behind such a huge concentration is identified as massive construction of building, stone crusher factory and exponential growth in vehicles, forest fire and other anthropogenic activities in the surrounding area. The SEM analysis suggest that silicon (Si), oxygen (O), sodium (Na), aluminium (Al) are dominantly present in form of silica (SiO_2), aluminosilicate (Si-Al rich), sea spray, mineral dust and gold (Au), zinc (Zn) and barium (Ba) may be present due to natural ores in surrounding hills in all seasons. But in the case of the post-monsoon season, nearly 25% of $PM_{2.5}$ consists of carbon particles, which is more likely to be coming from soot particle emission from biomass burning.

KEYWORDS

SEM, EDAX, Forest fire, Anthropogenic activities, Particulate matter ($PM_{2.5}$ and PM_{10})

1. INTRODUCTION

The particles in the atmosphere are a complex mixture of organic and inorganic species that play a very crucial role in cloud formation, distribution of solar radiation and cloud droplet nucleating ability, acidification, dry deposition and precipitation that support life in planet [1,2,3]. The sources of such atmospheric particles are mainly natural as well as anthropogenic. Activities, such as dust, sea spray, volcanic emission, industrial power plant and combustion of solid fuel for domestic use and exponential growth of vehicles. Almeida and Colbeck suggest that the airborne particulate matter (PM) is a complex mixture of various chemical varieties [4,5]. Loading of such particulate matters (PMs) particles in valley configuration along with metrological parameters and their chemical characteristics are mentioned by Gautam [6]. Generally, the aerosol can be reached in high altitude areas by valley breeze activity on the central Himalayan region [7]. The particles having a aerodynamic diameter less than 10 μm (PM_{10}) are called inhalable particles and below 2.5 μm ($PM_{2.5}$) are called respirable particles which are highly penetrable and can be reached to alveoli in human lungs [8]. The dispersion of PM_{10} and $PM_{2.5}$ is a worldwide issue that governs ambient air quality, visibility, various health issues such as respiratory and cardiovascular diseases [9]. Therefore, it is very important to understand their chemical composition and size distribution of ambient air at Alaknanda valley. The scanning electron microscope with energy dispersed X-ray analysis (SEM/EDAX) is often used by researchers to identify the chemical composition of airborne particles particulate matters (PMs) in ambient air. Scanning electron microscope with energy dispersed X-ray analysis (SEM/EDAX) allows us to collect some essential information of element composition particle density and morphology and also their possible originating sources of sample air at observation site [10].

To determine the possible sources of particulate matters (PMs) it is very essential to analyse their elemen-

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Assessment of climate change pattern in the Pauri Garhwal of the Western Himalayan Region: based on climate parameters and perceptions of forest-dependent communities

Shashidhar Kumar Jha, A. K. Negi, Juha Mikael Alatalo, R. S. Negi & Maneesh Kumar Patasaraiya

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Abstract

This study assessed the climate change in Pauri district, Uttarakhand, India, a region highly vulnerable to climate change with potentially high loss of livelihoods and lives. The scale of change in the district's climate was analyzed using meteorological station data (1901–2000) and grid data (1985–2015). Perceptions of climate change among forest-dependent communities in three altitude zones (< 1200 m asl (zone A); 1200–1800 m asl (zone B), and > 1800 m asl (zone C)) in the study region were surveyed with respect to 14 climate-specific indicators. Annual mean, maximum, and minimum temperature of seasonal data indicated increasing trends except monsoon. Percentage cloud cover showed an increase, of approximately 3%, while diurnal temperature displayed decreasing trends. Rainfall in the district showed a decreasing trend, with more than 50% of years 1985–2015 receiving less rainfall than the annual average. More than 90% of respondents in zones A and B, and around 65–70% respondents in zone C, reported changes in climate parameters. These findings confirm the long-term observable changes in climate in the region and demonstrate the utility of station data, grid data, and surveys of local communities' perceptions when analyzing climate change. The analysis provided important clues about the nature of climate changes in the district. The results can be used to reduce the gap between bottom-up understanding and top-down policies and to formulate precautionary and ongoing site-specific adaptation practices for communities in different altitude zones in the study region, leading to effective and efficient mitigation of climate change impacts.

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ORIGINAL ARTICLE

Characteristics and Variability of Carbonaceous Aerosols over a Semi Urban Location in Garhwal Himalayas

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Abstract

Extraction of organic carbon (OC) and elemental carbon (EC) were carried out over Srinagar, India, an ecologically sensitive semi-urban site in Garhwal Himalays. The $PM_{2.5}$ sampling was carried out during January to December, 2017 over the site. The OC and EC were extracted from $PM_{2.5}$ samples using a thermo optical OC/EC analyzer. Highest OC and EC concncentrations were found during postmonsoon (17.67 ± 1.1 μg/m^3 OC and 6.34 ± 0.75 EC) and Winter (17.31 ± 3.045 μg/m^3 OC and 6.32 ± 0.585 μg/m^3 EC) seasons are attributed to boundary layer dynamics and anthropogenic activities. The lower concentration of OC/EC was observed during monsoon season (11.64 ± 1.75 μgm^{-3} OC and 3.46 ± 0.19μgm^{-3} EC) owing to wet scavenging of aerosols and minimum count of forest fire/biomass buring incidences. Both pre-monsoon and post-monsoon season concentrations are also influenced by biomass burning in the IGP (Indo-Gangetic Plain) region and forest fires in the adjecent areas. The OC/EC ratio sounds that vehicular exhaust and biomass burning are the major source of OC/EC over the site. Generation of secondary organic carbon (SOC) at the region causes variability in OC/EC ratio in different seasons. It is found that 24–32% of PM2.5 is contributed by carbonaceous aerosols (OC and EC) over Srinagar. The pivotal role of meteorology in modulating OC/EC concentrations has been illustared in detail.

Keywords Himalayan valley · Elemental carbon · Organic carbon · Seasonal variation · Biomass burning · Influence on meteorology

1 Introduction

Carbonaceous aerosols are potential climate forcing agents and majorly exist in size range below 2.5 μm. Subset of these particles mainly include carbonaceous species like organic carbon (OC) and elemental carbon (EC). The chemical and optical properties of BC and EC are almost same and constitute the most solar absorptive particulates among the fine mode particulate matter (Chung and Seinfeld 2002; Watson et al. 2005). Carbonaceous aerosols account for almost 40% of total $PM_{2.5}$ mass in urban areas (Seinfeld and Pandis 1998). Incomplete combustion of fossil fuels and biomass burning produce EC in the atmosphere. However, oxidation of volatile organic compound (VOC) generate secondary organic carbon in the atmosphere in addition to primarily emitted organic carbon (Turpin and Huntzicker 1995). Intense combustion processes release EC in to the atmosphere. Temperature and oxygen availability are the major factors determining the amount of EC formed during a combustion process. Low temperature and less availability of oxygen produces more EC and vice versa in a closed chamber combustion process (Panicker et al. 2018). Fresh EC aerosols are more or less hydrophobic in nature and barely probable to act as CCN in usual atmospheric conditions due to non-significant hygroscopic growth and cloud condensation nuclei (CCN) activity (Tritscher et al. 2011). The ageing

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Pure and Applied Geophysics

Estimates of Carbonaceous Aerosol Radiative Forcing over a Semiurban Environment in Garhwal Himalayas

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Abstract—Continuous sampling of particulate matter ($PM_{2.5}$) was carried out over Srinagar, a semiurban site in Garhwal Himalayas, during January to December 2017. The organic and elemental carbon (OC and EC) values were extracted from $PM_{2.5}$ samples using a Thermo optical OC/EC analyzer. The radiative forcing due to carbonaceous aerosols was estimated using an optical model along with a radiative transfer model. The EC mass was found to be up to 7 μg m^{-3}, while the OC peaked at 17 μg m^{-3} during the experimental period. The EC forcing was found to range from -18.32 ± 3.91 W m^{-2} to -28.18 ± 8.09 W m^{-2} at the surface and $+8.57 \pm 2.15$ W m^{-2} to 13.83 ± 3.48 W m^{-2} at the top of the atmosphere (TOA), inducing atmospheric forcing of $+27.24 \pm 5.09$ to $+42.02 \pm 11.32$ W m^{-2} over Srinagar in different months. On the other hand, the OC forcing was found to be much weaker compared with the EC forcing, being $+1.37 \pm 0.95$ to $+2.342 \pm 1.67$ W m^{-2} in the atmosphere in different seasons. The forcing efficiency was estimated to determine the projection of the radiative forcing per unit optical depth, yielding a range of 271.94 ± 94 to 450.03 ± 59.11 W m^{-2} AOD^{-1} in the atmosphere for EC and 19.51 ± 9.13 to 36.96 ± 10.97 W m^{-2} AOD^{-1} for OC. The atmospheric heating rates of OC/EC were extracted and found to be 0.954 ± 0.31 to 1.46 ± 0.58 K day^{-1} for EC and 0.047 ± 0.023 to 0.081 ± 0.035 K day^{-1} for OC over Srinagar.

Key words: Elemental carbon, organic carbon, optical properties, radiative forcing, heating rates.

1. Introduction

Aerosols play a pivotal role in modulating Earth's radiation budget. They scatter and absorb solar radiation, leading to changes in the radiation balance known as direct radiative forcing (Srivastava et al. 2012; Tiwari et al. 2016). Indirectly, they influence the climate by modifying the cloud microphysics (Panicker et al. 2016). Carbonaceous aerosols are known to be an essential part of soot generated naturally due to forest fires, volcanic eruptions, and gas to particle conversion processes (Reddy and Venkataraman, 1999). Meanwhile, anthropogenic sources of carbonaceous aerosols include burning of biofuel/biomass and emissions from vehicular transport (Cherian et al. 2009; Bhist et al. 2016; Sahu et al. 2008; Kumar et al. 2011). Organic carbon (OC) and elemental carbon (EC) are two major carbonaceous aerosol species that have a strong influence on radiative forcing. EC is generally a highly absorbing aerosol species, being generated due to combustion at low temperatures with low oxygen availability (Panicker et al. 2018). OC is a mixture of different primary and secondary carbon components, being more of a scattering aerosol species with both water-soluble and water-insoluble components. Water-soluble OC (WSOC) has been found to dominate in the OC component in different environments worldwide, contributing up to 75% of total OC (Mayol−Bracero et al. 2002). Some studies have pointed out the seasonal variation in the contribution of WSOC to total OC (Sullivan et al. 2004). Many studies have documented the composition of WSOC and insoluble OC across the world (Stefano et al. 2000; Miyazaki et al. 2009; Saarikoski et al. 2008). However, studies on the contributions of EC and OC to the total radiative forcing are sparse, although a few studies have reported the contribution of Black Carbon (BC) to composite aerosols across India (Panicker et al. 2010; Sreekanth et al. 2007). It is found that BC/EC can

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Factors influencing farmers decisions to technological adoption for enhancing livelihoods security in Rudraprayag district, Uttarakhand, India

Rekha Dhanai, RS Negi and Santosh Singh

Abstract
This paper summarizes the results of an adoption study conducted in between 2014 and 2016 in district Rudraprayag, Uttarakhand, to determine the level and extent of adoption of selected technologies. This study aimed to identify reason of low adoption rates and policy lapses in adoption of technologies for future conduct of research and research-extension linkages. A sample of 604 household from 64 villages was randomly selected from three different blocks of the district to determine the distribution of adoption of the technologies. Semi-structured questionnaire and interview method were used to collect the primary data and survey questions used to identify the factors that affect farmer's decision on adoption of technology. Adoption rate was highest for the cases of inorganic fertilizer (52.21%), improved seed (19.48%), bio/vermicompost (11.03%), polyhouse (9.93%), water harvesting tank (6.99). The high rates of adoption may be due to extensive diffusion of technology. The results of the logistic regression model show that the age and education of household head (HHAge and HHEdu), land size (TLand), institutional support for adopting the new technology (InsSupp) and farmers cosmopoliteness (Cosmopo) are the main determinants of the adoption of new farm technology. The model shows that after keeping the other variables constant, the effect of variables such as age and education of the household head, area of agriculture land, institutional support and cosmopoliteness, favours adoption. This study will assist the policy makers to develop and extent area specific suitable technology with proper technical know-how for higher extension and adoption of the technology.

Keywords: Technology, adoption, extension, farmer's decision, cosmopoliteness

Introduction
India is one of the world's fastest growing economies. But the challenge is how to ensure future development in a sustainable and inclusive manner. The country has numerous challenges in different nature in terms of health, education, skills, agriculture/rural development, energy and so on. Challenges have also been imposed by exclusive and inequitable access due to multiple deprivations of class, caste and gender. Therefore, the government may consider expanding the scope of technological adoption through its extension programs. Modern machinery allows technically highly efficient farming and resource conservation. Innovative approaches and solutions, and looking beyond the conventional mode of performing various tasks are required to solve these problems. Innovative technologies could play a pivotal role not only in bringing about triggered growth and competitive environment in it, but also ensure inclusion of vulnerable groups in addition making the development environmentally sustainable.

The vast majority of farmers in developing countries like India are smallholders, with an estimated 85% of them farming less than two hectares (World Bank, 2007) [28]. These farmers mostly dependent on agro-based activities for their livelihood, but over 30 to 35% of them are threatened by the problems of unemployment and food insecurity. Hence, World Development Report (2008) [27] emphasized that the potential of agriculture to contribute to growth and poverty reduction depends on the productivity of smallholder farmers. And raising that productivity will require a much higher level of adoption of new agricultural practices and technologies than presently observed in the smallholder farming population (De Janvry & Sadoulet, 2002; World Bank, 2007) [28].

The agriculture of Uttarakhand is mostly rainfed and there is not much surplus for the market. As a result most of the able-bodied men have migrated to other places in search of employment and other diversifies their income through non-farm activities. Mostly women are left in the villages and they have started looking after the farms. The challenge is to change this structure and create employment opportunities through agriculture and allied activities.

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Fuel wood and Fodder Consumption Pattern in Gostu Gad Watershed, Pauri Garhwal, Uttarakhand

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Abstract

This paper aims to show acute changes in seasonal fuel and fodder consumption in Gostu Gad watershed, Pauri Garhwal Uttarakhand. The lack of alternate energy sources in this region is the major setback. By taking the data at three altitudinal ranges with three seasons was done by random selection of 120 households of different villages. The Freidman test was used for analyzing the data and it was observed that changes in fuelwood consumption were showing at different heights in the Gostu Gad watershed. Majority the use of fuel wood was for domestic cooking in the whole watershed and it was highest 1076.75 kg capita^{-1} year^{-1} at higher altitudes and lowest 616.85kg capita^{-1} year^{-1} in the middle altitudes. Gross annual consumption of fodder was highest 7927.80 kg in high altitudes and lowest 5642.90 kg in lower altitude villages. A proper study was done to identify the fuel consumption pattern on pilot basis in whole watershed and it revealed that at present the fuelwood use by households is 94.6% despite the other fuels like kerosene, LPG are also in the usage.

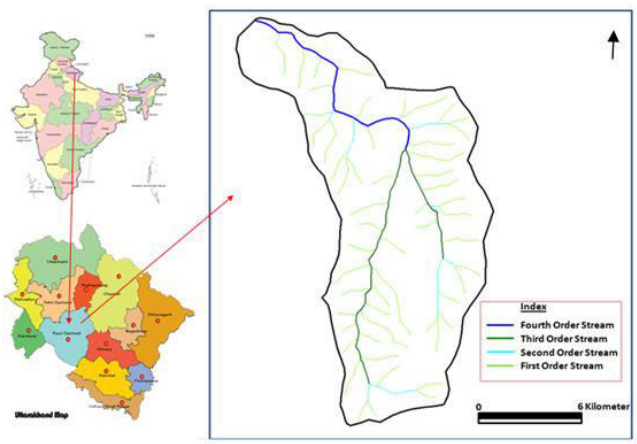
Key Words: Fuel wood, Fodder

INTRODUCTION

In India the mountainous village areas completely depends on the fuel wood which is considered to be the main source of energy even successfully meeting the all cooking energy requirements. Perhaps the majority of population in India lives in the rural regions and they wholly thrive on fuel wood, crop residues and waste of the animals. Forests and many more sites near these forests fulfill about 70 % of energy requirement by generating fuelwood that leads to removal of about 50 million tons of wood every year. This kind of natural resource management is even followed by other developing countries too. On other hand the increasing demand for fuelwood leads to degradation of resources causing Deforestation. Now shifting to bio energy can bring boons like recovery of degraded Land, prevent soil erosions and watershed protection. By entirely shifting from fuelwood to other alternate energy sources like biogas, kerosene, solar, and wind energy which do not cause environment degradation and thus it can eventually reduce the pressure on forests sites. The watershed provides variety of forest vegetations like in the upper zones of watershed has abundance of Quercus Leucotrichophora (Banj) and Rhododandron arboretum (Burans) while in the middle and lower zones has Pinus roxburghii (Chir), Terminolia belliricia (Bahera) & Terminolia chebula (Harda) in abundance. Most of the parts of watershed has spread of Pine forests. Several anthropogenic pressures such as grazing, cutting of ground herbage, trampling, lopping of tree and bushes for fuelwood and fodder has drastically affected the growth of Oak forests in these study sites and in this paper we are attempting to show the changes in seasonal bio-energy consumption at different altitudes.

LOCATION OF STUDY AREA

The catchment of Gostu Gad is lies between 30^0 12" to 30^0 15" N Latitude and 78^0 55" to 78^0 57" E Longitudes which occupies an area of 21.609 Km^2 with an elevation ranging between 622 m to 2165 m above mean sea level. Gostu gad area lies in inner Garhwal lesser Himalayas and are identified by the gentle and mature topography and it also originates from northern slope of Khirsu ridge (2165m) and joins the river Alaknanada at Dungripanth (622m). The data was collected from the villages of Gostu Gad watershed in Pauri Garhwal District Uttarakhand and then used in this paper. According to the data the main source of fuelwood and fodder is forest and agricultural area while the major energy source is wood which is used for cooking and for heating purpose. Even electricity, kerosene and oil lamps were used for lighting purposes. It was observed that majority of middle class families had their own LPG (Liquefied Petroleum Gas) however the use of traditional (Chulha) was more common for cooking while LPG was used for only making Tea. Abundant Forest resources in villages have made the villagers not pay for domestic energy. It was found that greater amount of fuelwood is collected in the winter season like from the month of October to March since the demand for domestic energy at highest point and demand for labour is relatively low.



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Trends Analysis of Wind in Srinagar Garhwal Valley, Uttarakhand, India

, , R. S. Negi

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Abstrakty:

EN Wind results from the air in motion. Air in motion arises from a pressure gradient. Wind direction and wind speed are two characteristics of the wind, whose inter-relationships may give us an insight into the prevailing weather condition at a particular place. This study examines the trend analysis of the wind direction and wind speed pattern of Srinagar Garhwal Valley, Uttarakhand. The average wind speed in Srinagar Valley is 2.923± 1.232 m/s. As it is seen the most frequent wind in Srinagar Garhwal has a speed from 0.50 to 2.10 m/s in the northwest direction.

Słowa kluczowe:
EN AWS Srinagar Garhwal Wind Direction Wind Speed

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RESEARCH PAPER

Chemical Characteristics of Atmospheric Aerosol at Alaknanda Valley (Srinagar) in the Central Himalaya Region, India

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Abstract

Measurements of fine ($PM_{2.5}$) and inhalable (PM_{10}) particles were collected at the Alaknanda Valley in the heart of Garhwal region during December 2015–December 2016. Collected samples of PMs were analyzed for major chemical species as anions (F^-, Cl^-, SO_4^{2-}, NO_2^- and NO_3^-) and cations (Na^+, NH_4^+, K^+, Ca^{2+} and Mg^{2+}) by ion chromatography. During the study period, the concentrations of $PM_{2.5}$ and PM_{10} were 78.7 ± 25.1 and 111.8 ± 23.4 μg m^{-3}, respectively. The measured chemical species were found a large variability in different seasons due to the impact of emissions and meteorological parameters. The measured water-soluble (WS) chemical species of $PM_{2.5}$ and PM_{10} were 43% (33.7 μg m^{-3}) and 57% (64.2 μg m^{-3}), respectively, with the highest concentrations during the winter season followed by summer, monsoon and post-monsoon seasons. A significant positive correlation was observed between NH_4^+ and other species (Cl^-, SO_4^{2-} and NO_3^-) in both $PM_{2.5}$ and PM_{10}, which indicates its presence in the atmosphere as ammonium salts. As a result, NH_4^+ play a crucial role in neutralization of acidic species in the winter season; however, the contrary feature was observed in the summer season where Ca^{2+} was responsible for the main neutralizing species, mainly transported from the inland region during the summer. Principal component analysis shows that secondary aerosol, biomass burning, and soil-driven dust were the possible sources of the measured species over the station. Further, air mass back trajectory analyses indicate that the highest mass concentrations of PMs and WS chemical species were in the post-monsoon season when the air masses pass from eastern Pakistan and western part of India over receptor site. In the winter season, the concentrations of PMs and WS species were highest (second) when the air masses transported from a long distance up to Southern Afghanistan covering with Pakistan and western part of India. In overall, the study suggests the long-range transport of pollutants plays a crucial role in the enhancement of PMs over Alaknanda valley region.

Keywords Particulate matter · Aerosol chemistry · Water-soluble species · PCA · Back trajectory analyses

Introduction

The atmospheric aerosol is linked to poor air quality, adverse health effects and heat balance of the Earth directly through absorbing/scattering the solar radiation, indirectly by influencing cloud microphysics and possibly by changing the heterogeneous chemistry of reactive greenhouse gases (IPCC 2007). The enhanced pollutant emissions associated with the fast-growing economies of Southeastern Asian countries have led to the progressive increase of aerosol concentrations above the natural background (Ram et al. 2008; 2010; Chatterjee et al. 2010). Aerosol-enriched boundary layer air can be transported to the higher altitudes by valley breeze processes on the

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RESEARCH ARTICLE

Livelihood Vulnerability Associated with Forest Fire in Pauri-Garhwal, Western Himalaya

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Abstract:

Background:

The livelihood of mountainous communities of Himalayan region closely knotted with forest related activities. However, forest degradation especially forest fire significantly affects the mountainous livelihood and hence, there is an urgent need to describe, evaluate and understand specificity of mountainous areas to forest fire.

Methods:

In this view, a study on livelihood vulnerability with forest fire of High Altitude Zone (HAZ) and Low Altitude Zone (LAZ) was assessed with Livelihood Vulnerability Index (LVI). It uses 35 indicators, reduced to six components to create an overall index. Each component is composed of set of indicators and they are function of observable variables. The framework uses primary data and employs maximum-minimum normalization to restrict the value range of indicators between 0 to 1.

Results:

The value near to 0 shows lower vulnerability. The overall vulnerability of HAZ region is higher, that might be attributed to higher dependency on forest; live in proximity of forest; unstable socioeconomic condition; less infrastructural development and higher exposure to climatic extreme events.

Conclusion:

Therefore, the adaptive capacity of HAZ should be strengthened in a cross cutting manner for reducing livelihood vulnerability to forest fire. The sectors specific developmental policies/programmes should also be rationalized through bottom up adaptation planning with special reference to forest fire vulnerability.

Keywords: Adaptive capacity, Forest fire, Himalaya, Livelihood vulnerability index, High Altitude Zone (HAZ), Low Altitude Zone (LAZ).

1. INTRODUCTION

Forest is one of the most valuable terrestrial ecosystems that play a crucial role in maintaining environmental balance. It provides numerous goods and services, and maintains life support system essential for life on earth. Forests soak up carbon dioxide from the atmosphere offsetting anthropogenic emissions. Protecting forests, therefore, has a double-cooling effect, by reducing carbon emissions and by maintaining high levels of evaporation from the canopy (Dahal *et al*, 2009). However, forests are in great anthropogenic pressure due to the ever-increasing demand for forest products (Gulati and Sharma, 2000) and dependency of about 60 million forest dependents.

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CASE REPORT

Natural and Anthropogenic Impacts on Forest Structure: A Case Study of Uttarakhand State

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Abstract: Forests are among the most important natural resources in Uttarakhand as they occupy 71% of the geographic area and contribute a good share in state economy. They are rich repositories of biodiversity and are providers of ecosystem goods and services to both regional and global community. People are dependent on forests for fuel wood, grass and other biomass. But unfortunately recent trend of data shows a huge degradation of forestland due to natural and anthropogenic activities. Variations in climatic condition and natural disasters are triggering rate of degradation of forests in Uttarakhand. The present paper reviews the status of forest in Uttarakhand and discusses the major natural and anthropogenic factors responsible for its degradation.

Keywords: Biodiversity, Climate Change, Forest fire, Forestland, Global warming, Uttarakhand.

1. INTRODUCTION

1.1. Geographical Location of Study Area

Uttarakhand is the 27th state of Republic of India which lies between 28 44' & 31 28' N Latitude and 77 35' & 81 01' E longitude. It was carved out of Uttar Pradesh on 9th November 2000 and was divided into two divisions of Garhwal and Kumaon with total of 13 districts namely Pithoragarh, Bageshwar, Champawat, Nainital, Pithoragarh, Udham Singh Nagar, Dehradun, Haridwar, Tehri Garhwal, Uttarkashi, Chamoli, Pauri Garhwal, Rudraprayag. It has a total geographical area of 53,483 km^2, of which large area is mountainous with under snow cover and steep slopes. It shares an international boundary with Nepal in the East and China in the North. In the West, it touches state Himachal Pradesh, and in the South, Uttar Pradesh. The human population of the state is 101.167 lakhs (2011census) out of which approximately 70 percent lives in rural areas. There are four major river systems *viz*. Ganga, Yamuna, Ramganga and Sharda originating from the state along with their tributaries serving as the prime source of water for drinking, irrigation and hydropower. A brief statistics of Uttarakhand state is mentioned in Table **1**.

1.2. Classification of Study Area

The major wealth of the state is its rich biodiversity forests. Based on altitude different climate zones are classified as warm temperate (900 m-1800 m), cool temperate (1800 m-2400 m), cold zones (2400 m-3000 m), alpine zone (3000 m-4000 m), glacier zone (4000 m-4800 m), and frozen zone (above 4800 m). The average annual rainfall is about 1550 mm. Based on land elevation, the State is classified as terrain region (less than 300 m above msl), lower hilly region (300-600 m), upper hilly region (600- 2400 m) high altitude region (2400-4500 m) and upper high altitude region (above 4500 m). Udham Singh Nagar and Haridwar are the only plain districts in the State. The state comprises of five lithotectonically and physiographically distinct subdivisions namely, the Outer Himalaya (comprising the Tarai and

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PHYSICOCHEMICAL ASSESSMENT OF SOIL IN KYUNJA GAD WATERSHED, DISTRICT RUDRAPRAYAG, UTTRAKHAND, INDIA

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Abstract

Physicochemical analysis of soil provides information about the current environmental status of the regions. In this present study we focus on agricultural soils with physical and chemical properties. Soil samples were collected from three different depth viz., 0-10, 10-20 and 20-30 cm from agriculture land and also from six different locations covering Kyunja Gad Watershed, district Rudraprayag (Uttrakhand) India during the month of January to December 2016. Part of analysis contain in soil texture (sand 83.70% to 99.61%, silt 1.89 % to 13.74 % and clay 0.11–2.93%), water holding capacity (23.8% to 33.04%), pH (6.6 to 7.4), Carbon (0.56% to 0.82%), potassium (112-190.4 kg^{-ha}). phosphorous (27.3 Kg/hectare to 41.7 Kg/hectare) and Sulfur ranged from 14.58 ppm to 18.38 ppm. Physiochemical results showed that agriculture soil of study area had nutrient rich.

Key words : Agriculture, parameters, physico-chemical analysis, Kyunja Gad Watershed.

Introduction

Soil physico-chemical properties are related to field morphology and regulate the qualitative and quantitative characteristics of plant growth to a considerable level. Thus the importance of physico-chemical properties of soil in the domain of system analysis needs to be taken into consideration (Mahajan and Sharma, 2015). The Central Himalaya has enormous kind of topography, climate and soil status, which form a very intricate ecosystem. Since, the vegetation zones in this region clearly reflect edaphic factor and climatic changes (Bhatt, Purohit, 2009 and Bhatt, 1991 and Upreti *et al*., 2016) and at the same time the information of physic-chemical properties of agricultural soils and climatic conditions of Central Himalaya is small. However, the present study was undertaken to investigate the soil properties in relation to agricultural land of the Kyunja Gad Watershed, District Rudraprayag, Uttrakhand, India.

Study area

The present study area is Kyunja Gad Watershed lies in the Augustmuni block of District Rudraprayag, Uttarakhand. Kyunja Gad Watershed is located in north part of the district. Geographically, the Watershed lies between the $30^{0}28'$ to 30^{0} 22'7'' N latitudes and $79^{0}4'2''$ to $78^{0}10'6''$ E longitude which covers an area of 32.14 km^2. Kyunja Gad is a tributary of river Mandakini and originates from the Mohankhal peak (2,400 m). Nil Gad, Loha Gad, Bhanaj Gad are the main sub-streams/ tributaries of the Kyunja Gad. The Kyunja Gad joins the Mandakini River near Chandrapuri (800 m). The elevation in the Kyunja Gad Watershed ranges from 800 to 3,000 m above SL. Most of the village settlements are situated between 800 and 2,400 m elevation. The study area falls in Survey of India (1:50,000) toposheets No 53 N/3. The entire Kyunja Gad Watershed covered of 46 villages. Geologically the study area lies in the Lesser Himalayan region. The watershed area has been located in the Garhwal Group between two major fault zones *viz*. Alaknada fault towards south and MCT towards north. The two local faults kande fault, which runs parallel to the MCT and Chimothi faults also pass through this area (Fuchs and Sinha, 1978). Mainly Phyllite, Granite gnenisses are exposed in the Kyunja Watershed. While the Partoli quartzites are exposed in the upper part of the Bhanaj ridge.

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Synoptic development through Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) in Uttarakhand State

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Abstract

Rural Development in India is one of the most imperative issues for the enlargement of Indian economy. In order to overcome all these problems especially rural unemployment, Government of India enacted. The Mahatma Gandhi National Rural Employment Guarantee Act enacted by legislation on August 25, 2005 and it was on 2nd October 2009. The MGNREGA has completed ten years since its inception in India". The aim of the act is to improve livelihood security of the household in rural areas of the country by providing at least 100 days of guaranteed employment in every financial year of every household whose adult member volunteer to do the unskilled work. A country's development has always been measured through its overall efficiency in their important sectors. This can be identified through the standard of livings of that country's people. The status of a 'developed' country is absolutely use-less, when the people in that country have do not get the opportunity to include their 'livings' in various economic operations. The 'MGNREGA' is one of a scheme, introduced in the year of 2006 with the ultimate objective to provide employment opportunities to the people who are especially residing in the rural areas. Proper implementation of schemes like this will definitely improve their 'earnings' and there by purchasing power which leads improvements in standards of livings. The act was introduced in Uttarakhand, the scheme was initially launched in 3 districts i.e., Chamoli, Champawat and Tehri in 2006-07 (Phase-1). In second phase (2007-08), two additional districts, i.e., Haridwar and Udhamsingh Nagar were added. In the last phase, all the remaining districts have been notified under the scheme. This paper tries to analyze the scheme of 'MGNREGA' in terms of its achievements and its impact on the inclusive growth since inception of the act.

Keywords: *Development, Economy, Employment, MGNREGA*

1. Introduction

Poverty and unemployment are the two main obstructions in the pave of growth and development of an any nation. The nation who succeeds in crossing these obstructions easily resolves the problems of poverty (Stina *et al.,* 2015). We all know that poverty is a curse in the humankind. Poverty is the source of unemployment, social exclusion, crime and other social, political and economic problems. It has been an important impediment in the way of growth and development of a country (Prasanna & Leelavathi 2014). In India, since independence, many developmental plans have been formulated and adopted by the different government (Sumarbin 2014). Among those developmental plans, using public employment as a social security measure and for poverty alleviation measure in rural areas is very common (Pani & Iyer 2011). After three decades of experimentation, the government launched major schemes like Jawahar Rozgar Yojana, Employment Assurance Scheme, Food for Work Programme, Jawahar Gram Samridhi Yojana and Sampoorna Grameen Rozgar Yojana that were forerunners to Mahatma Gandhi NREGA (Sing & Singh 2013).

MGNREGA is a demand driven employment programme which was introduced with an aim to guarantee at least 100 days of unskilled employment to all the poor families in rural areas of India (Rahaman & Sheereen 2013). This scheme is different from other employment programmes on the basis of two important facts viz. it is demand

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SHORT COMMUNICATION

Temperature and Rainfall Trend in Alaknanda Valley Srinagar Garhwal, Uttarakhand, India

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ABSTRACT

The rainfall and temperatures are the most important parameters among the atmosphere as these parameters decide the ecological situation of the specific area, which affects the agricultural productivity. The temperature, and rainfall trends are analysed for meteorological data of Automatic Weather Station (AWS), was installed September 2009 with 22 meteorological parameters in the Department of Rural Technology, HNB Garhwal, University, Srinagar Garhwal, and Uttarakhand. In the study assess the seven-year change in temperature and rainfall has been examination by linear tread analysis. It is observed that in velley of Srinagar Garhwal, Uttarakhand, coefficient of variation for mean temperature for Srinagar Garhwal Valley is highest in the month of February and lowest in the month of August. This means that mean temperature is most stable in the month of August and total monthly rainfall observed highest in the month of November and minimum for the month of July. This shows that rainfall is more stable in the month of July and is more variable in the month of November for the Valley.

***Keywords*:** Climate Change, Meteorological data, Rainfall, Trend, Temperature

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FODDER PLANTS OF MACHLAD GAD WATERSHED, DISTRICT PAURI GARHWAL, UTTARAKHAND

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ABSTRACT

Fodder is an important component of agricultural production systems in hills as it supports the livestock. In Garhwal a part of Indian Central Himalayan Region, fodder is collected by the shrubs, herbs, and grasses and also by the lopping biomass of trees. The present study was done to know about the fodder plants utilization pattern in Muchald Gad watershed in Pauri Garhwal district, Uttarakhand. The present examination depicts 46 species with 22 families, which are the source of fodder. The plants beside their native names and other details, pertinent comments are also enumerated such as results of plant investigation, Consequences of fodder plant examination conducted during October 2016 to June 2017.

Keywords: Fodder, Garhwal Himalaya, Livestock, Watershed.

INTRODUCTION

Fodder is an important component of agricultural production systems in hills as it supports the livestock. Biomass extraction in the form of fodder assortment is also the foremost prevailing compress on forests in countries, where rural populations mainly depend on these activities (Hegde *et al.,* 2000). However, rural populations rely considerably on these activities for household and livelihood needs (Hegde *et al.,* 2000; Misra 2010) In India the forests altogether approximately 40% of the energy needs of the country; of that about 80% is use in the rural regions and about 30% for fodder consumption of the cattle population (Verma 2009; Awasti *et al.,* 2003). An accumulation of fodder is the first step that turns the wheel of the agricultural economy of the rural community (Makino 2009; Chettri *et al.,* 2002). Cultivation along with animal husbandry is the most important occupation and source of livelihood for over 70% of the population of Uttarakhand state. Uttarakhand is well thriving variety of livestock (Dhanai *et al.,* 2014; Dhyani *et al.,* 2011; Kumar 2005)

Livestock converts fodder shrubs and grasses from forests, crop residues and many fodder plats into compost through digestion. Large population and low productiveness are the pattern of livestock within the state, across all species. Cattle like Cow and buffaloes are the dominant spirit animal and also the main keep of the dairy industry, while sheep and goat are the popular kindred among marginal farmers, sub-marginal and landless farmers. In the part of Central Himalaya especially Garhwal region, about 77.4% of the total human population is rural, because of geographical abstruse and very low connectivity with other areas (Heltberg *et al.,* 2000; Chandra *et al.,* 2008). This discommodity in the area and disallowed socio-economic status of locals are responsible for the total ependence of nearby the forest areas for their fuelwood and fodder demands (Dhanai *et al.,* 2015; Bhatt *et al.,* 2004; Dewees 1989; Singh *et al.,* 1988).

Moreover, in Uttarakhand hills, it is accepted that women are mainly responsible for the collection of fodder. Villagers rear these animals for the milk that adds to their income. (Chandra *et al.,* 2008; Sati 2012). The key constraint within the central and north– western Himalaya in improving livestock and enhancing milk production is that the livestock feeds are inadequate and unbalanced. The most major issue is the unavailability of green forage, particularly in winter, causing a lack of protein and vitamins, resulting in low milk production, shortened breeding span and decreased working capacity of bullocks (Palni *et al.,* 1998; Shaheen *et al.,* 2011; Singh *et al.,* 2010). Aims of the study

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Impact of MGNREGA on Poverty and Ameliorate Socio-economic Status: A Study in Pauri Garhwal District of Uttarakhand

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

India is mostly an agricultural country in which the power of rural unskilled labour is very high and the most people of the rural poor depend mostly on the wages they earn through unskilled, informal, and manual labour. The main effect of the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) is to improve the livelihood conditions of the rural poor by providing employment. The Act provides an opportunity to work in the lean season, which helps rural poor to keep the consumption level and strengthen the livelihood resource base during this critical period. Only the growth of the economy cannot create social justice and balanced development unless it is attached with poverty improvement and employment generating opportunity for a poor and marginalised section of the society. It was perhaps the largest and most ambitious social security and public works programme in the world. Thus, a study on the impact of MGNREGA in generating employment and increase in income of the selected respondents in selected blocks of the district Pauri Garhwal and linear regression has been used as the statistical tool to measure such impact. The results revealed that there is a significant impact of MGNREGA in generating employment and increase in income of the respondents in the selected village of the district.

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PHYSICO CHEMICAL ANALYSIS OF SOIL: A CASE STUDY OF TAKOLI GAD WATERSHED, GARHWAL HIMALAYA

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Abstract
The present study was undertaken in Takoli Gad watershed, Uttarakhand. The aim of the present study was to assess the chemical and physical properties of soils in different landuse. Chemical properties of the soil i.e. pH, organic carbon, total nitrogen, phosphorus, potash and physical properties of soil i.e. soil moisture, water holding capacity, bulk density were analyzed for three different depths viz , 0-10, 10-20 and 20-30 cm for each of the three land use i.e agriculture land, forest land and barren land of the area. The soils of the investigated area are mostly acidic to neutral.
Keywords: Nitrogen, Phosphorus, potash, soil moisture, water holding capacity, bulk density.

I. INTRODUCTION

Soil is a natural body having depth and surface area existing as a continuous cover on land surface except on steep slopes. It is produce of natural destruction and synthetic forces. The physical and chemical weathering of rock and minerals results into the formation of unconsolidated "debris" known as regolith. The upper biochemically weathered part of regolith is soil. The upper layer of soil is generally rich in organic matter.

An undisturbed, well developed soil have distinct profile. A very shallow skeletal soils to very deep soils are reported in this part of Himalaya. The profile characteristic of soil vary widely from place to place. Early pedological works in hill area, has been made by various workers like Rawat (1983), Gupta et.al (1984), Biswas et.al (1987), Dhar et.al (1988), Gangopadhyay et.al (1990), Sharma et.al (1989), Dutta et.al (1990) etc.

II. LOCATION OF AREA

Geographically the catchment (Takoli Gad) is lying between the 30^0 14' to 30^0 23' N latitude and 78^0 37' to 78^0 46' E longitudes in the Survey of India toposheet No. 53 J/11, 53 J/12 and 53 J/15 with an area of about 131.43 Km^2. It comes under jurisdiction of district Tehri Garhwal, Uttarakhand.

The area is approached by Kirtinagar-Tehri and Kirtinagar- Chauki all weather roads.

The area falls in inner Garhwal lesser Himalaya and is characterized by gentle and mature topography.

The Takoli Gad originates from the Eastern slope of the Chandrabadni Peak (2278 meter) and join the Alaknanda at Juyal Garh (605 meter). Jakhand and Dagar Gad are the two main sub streams / tributaries of the Takoli Gad watershed.

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Socio-economic Impact of Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA): A Case study in Pauri Garhwal District of Uttarakhand

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Submit Article

Abstract

The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), 2005 which is a rights-based flagship scheme of the Government of India with effect from 2 February, 2006, guarantees at least 100 days of wage employment in a given financial year to every rural household whose adult members volunteer to do unskilled manual work. The MGNREGA is also intended to create durable community assets which would enhance productivity along with an increase in demand for labour. The present study conducted in the pauri Garhwal district of Uttarakhand, has examined the socio-economie impact of MGNREGA on the rural poor. The study is based on 135 respondents drawan by simple randam sampling method from 6 Gram Panchayat which had more MGNREGA beneficiaries selected from three randomly selected block in the district Pauri.

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Study of maximum and minimum temperatures trends at Srinagar Garhwal Valley, Uttarakhand India

Santosh Singh, RS Negi and Alok Sagar Gautam

Abstract
This paper, attempts to study the variation in temperature over Srinagar Garhwal Valley of Uttarakhand, India, during the period 2010-2016. In the study assess the seven-year change in temperature has been evaluated by Mann–Kendall rank statistics and CV. The result indicates significant slightly increase in winter temperature at 0.01 level. It is observed that in valley of Srinagar Garhwal, Uttarakhand, coefficient of variation for mean temperature for Srinagar Garhwal Valley is highest in the month of December, it is observed as 75.87 % whereas it is lowest in the month of August, it is 27.40%. This means that mean temperature is most stable in the month of August and least stable in the month of December for the Srinagar Garhwal Valley.

Keywords: srinagar, uttarakhand, garhwal valley, temperatures

1. Introduction
Numerous climatologists (Jones *et al.,* 1999 and Parker and Horton 2015, IPCC 2001, Vinnikov and Grody, 2003) [1, 2, 5, 3] agree that there has been a large-scale warming of the Earth's surface over the last hundred years or so. This warming up of the Earth during the 20th century brought with it a decrease in the area of the world affected by exceptionally cool temperatures, and to a lesser extent, an increase in the area affected by exceptionally warm temperatures (Jones *et al.,* 1999) [1]. Some analyses of long time-series of temperatures on a hemispheric and global scale (IPCC 2001) [3] have indicated a warming rate of 0.3-0.6 ºC since the mid-19th century, due to either anthropogenic causes (IPCC, 2001) [3] or astronomic causes (Soon *et al.,* 2000, Landscheidt 2000). The Third Assessment Report projections for the present century are that average temperature rises by 2100 would be in the range of 1.4-5.8 ºC (IPCC 2001 & 2001) [3]. Records show that global temperatures, averaged world-wide over the land and sea, rose 0.6 ± 0.2 ºC during the 20th century. A number of recent studies have been devoted to global, hemispherical, or regional long-term temperature variations. On a global scale, climatologically studies indicate an increase of 0.3-0.6 ºC of the surface air temperature 0.5-0.7 ºC for the Northern Hemisphere since 1860 (Jones *et al.,* 1999, Jones *et al.,* 1986, Jones 1987) [1, 4, 9], while the eighth warmest years ever recorded were observed after (Brasseur and Roeckner 2005). A broad consensus of scientists has concluded that, the earth's surface air temperature increased by about 0.6 ºC during the 20th century, that most of the warming during the latter half ofthe century is attributable to human emissions of greenhouse gases, and that temperature increases were greatest during the 1990s (IPCC, 2001) [3]. Numerous other factors such as variations in solar radiation and pollutant aerosols also contribute to climate change (Scafetta and West 2005, Pielke 2005) [12, 13]. The IPCC panel further concluded that global temperature increases are likely to persist in the 21st century and will probably be accompanied by changes in precipitation and runoff amounts. Future climate change is more difficult to predict with great certainty at the regional scale due to spatial resolution limitations of current climate models and to the likely influence of unaccounted for factors such as regional land use change (Savelieva *et al*., 2000) [14].
Several studies (Balling and Idso, 1989; Karl *et al*., 1988; Goodrich 1992) [15, 22, 17] published in the last 15 years have attempted to assess the effects of urbanization on local and regional climate. A study by (Jones *et al*. 1990) [10] on urbanization and related temperature variation indicates that the impact of urbanization on the mean surface temperature would be no more than 0.05 1C per 100 years. A similar study by (Thapliyal and Kulshreshtha 1991) [20] on temperature trends over Indian cities indicates a slight warming within the limits of 1 SD between 1901 and 1990. It is now recognized that urbanization and changing land-use

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Original Research Article

Women's Empowerment and MGNREGA: Exploratory Study in Pauri Garhwal District, Uttarakhand, India

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A B S T R A C T

This paper is an attempt to investigate the level of economic empowerment gained by women engaged in Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) within the in the district of Pauri Garhwal, Uttarakhand. The key objective of the MGNREGA is to provide social security to rural households by guaranteeing one hundred days of paid employment in publicly works every financial year. Based on nine variables (education, land ownership, ownership of other assets, control over income contributed by a woman to her family, control over the income of the family, savings, access to credit, social participation, cash income earned from income generating activities, the research compared the magnitude of women's empowerment before and after getting involved in MGNREGA. The findings suggest that whereas MGNREGA is an indispensable dive to making sure economic empowerment to rural women; however, the scheme has not been enforced properly within the district women and men not obtaining 100 days of employment, irregular mode of payment, very slow progress and poor quality in public works.

Keywords

Frequency, Women's empowerment, MGNREGA, Pauri Garhwal, Uttarakhand

Introduction

There is huge literature on problems concerning about rural women's empowerment through the prevalent community works programme of India. National Employment Guarantee Act, 2005, first started in 200 districts since 2 February 2006 and renamed after the Father of the Nation as Mahatma Gandhi National Rural Employment Act (MGNREGA) since 02 October 2009 on his birth anniversary (Dutta *et al.,* 2012; Negi *et al.,* 2015; Liu and Barret, 2013; Narayanan and Das, 2014; also Bhattacharyya and Vauquline, 2013; Roy and Singh 2010 and Dhaka *et al.,* 2015). Underscoring the human rights notion of right to work the act guarantees one hundred days of paid employment in unskilled works to poor rural households among the every financial year aimed toward granting social security (dutta *et al.,* 2012). Apart from this basic objective, the other objectives of the act are the creation of durable assets and strengthening the livelihood resources based on the rural poor, generation of productive assets, protection of environment, empowerment of rural women, reduction of rural-urban migration and fostering social equity. However, after a decade of performance, evidence suggests that MGNREGA has been suffering from

Awareness about MGNREGA Provisions: Some Facts from the District Pauri Garhwal Uttarakhand, India

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Abstract— Mahatma Gandhi National Rural Employment Guarantee Act, (MGNREGA) has the potential to change the geography of poverty. This act is to enhance livelihood security in rural areas by providing at least 100 days of guaranteed wage employment in a financial year to every household. The present study was conducted in Pauri Garhwal district of Uttarakhand. This study takes up the issues related to the awareness about an ambitious welfare programme targeting the rural population of India, the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). The study is based on a primary survey and finds a general lack of awareness about the basic guidelines and the legal entitlements among the intended beneficiaries.

Key words: Employment, Implementation, Households, MGNREGA

I. INTRODUCTION

The Indian government has taken up various poverty alleviation programmes comprising of wage employment programmes, rural housing schemes and a public distribution system have been initiated from time to time. Some were partially successful in addressing the issue of poverty whereas others suffered from major flaws in their implementation. National Rural Employment Programme (NREP) 1980-89; Rural Landless Employment Guarantee Programme (RLEGP) 1983-89; Jawahar Rozgar Yojana (JRY) 1989-99; Employment Assurance Scheme (EAS) 1993-99; Jawahar Gram Samridhi Yojana (JGSY) 1999-2002; Sampoorna Grameen Rozgar Yojana (SGRY) since September 2001; National Food for Work Programme (NFFWP) since November 14, 2004 (SGRY and NFFWP now merged with NREGS 2005) were national level rural employment generation schemes. However these programmes could not provide social security to the rural poor.

Mobilization and awareness are among the major factors that determine successful implementation of poverty alleviating schemes including public employment programmes, cash transfers and microfinance interventions. However, majority of the rural population in developing countries have low levels of literacy. Thus, creating awareness among the rural masses about any of these development programmes has been a major concern among the policy makers in these countries.

One of the most demanding challenges for any anti poverty scheme to succeed is the task of generating awareness about the scheme among the targeted population. Without awareness about these schemes, there is always a possibility that full benefits may not accrue to the intended beneficiaries. According to Shah and Mehta (2008), lack of awareness amongst the potential beneficiaries is one of the main reasons behind the constrained impact of the aforesaid scheme.

A. Mahatma Gandhi National Rural Employment Guarantee Act

As the Table 1, depicts that the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) is an Indian job guarantee scheme, enacted by legislation on August 25, 2005. The Act received assent of the President on September 5, 2005 and was notified in the Gazette of India on September 7, 2005. The law was initially called the National Rural Employment Guarantee Act (NREGA) but was renamed as Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGA) on 2 October 2009. The Act was legalized and notified in 200 districts in the first phase with effect from February 2nd 2006 and then extended to an additional 130 districts in the financial year 2007-2008 out of it 113 districts were notified with effect from April 1st 2007, and 17 districts in Uttar Pradesh were notified with effect from May 15th 2007. The remaining districts have been notified under MGNREGA with effect from April 1st 2008.

Uttarakhand, the MGNREGA was initially launched in 3 districts i.e., Chamoli, Champawat and Tehri in 2006-07 (Phase 1). Two additional districts, i.e., Haridwar and Udham Singh Nagar were adopted in phase II (2007-08). In the last phase, all the remaining districts have been notified under the NREGS.

MGNREGA was applied to district Pauri Garhwal in the third phase and the implementation of MGNREGA scheme in the district commenced on April 1, 2008.

August 25th , 2005	NREGa enacted by legalization
September 5th, 2005	Assent of the President
September 7th,2005	Notified in the Gazette of India
February 2nd 2006	Came into force in 200 districts
April 1st, 2007	113 more districts were notified
May 15th, 2007	17 more districts were notified
April 1st, 2008	Notified in the remaining rural districts
October 2nd, 2009	Renamed as MGNREGA

Table 1: Time-Line of MGNREGA
Source: compiled from various repors of MGNREGA

The essential features of MGNREGA

- Adult members of a rural household, willing to do unskilled manual work, may apply for registration in writing or orally to the local Gram Panchayat.
- The Gram Panchayat after due verification will issue a Job Card. The Job Card will bear the photograph of all adult members of the household willing to work under NREGA and is free of cost.
- The Job Card should be issued within 15 days of application.
- A Job Card holder may submit a written application for employment to the Gram Panchayat, stating the time

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RESEARCH ARTICLE

GEOGRAPHICAL INFORMATION SYSTEM BASED MORPHOMETRIC ANALYSIS OF TAKOLI GAD WATERSHED, TEHRI GARHWAL, UTTARAKHAND, INDIA

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ABSTRACT

The quantitative analysis of drainage system is an important aspect of characterization of watersheds. Using watershed as a basic unit in morphometric analysis is the most logical choice because all hydrologic and geomorphic processes occur within the watershed. The geographical position of watershed is 30^0 14' to 30^0 23' N latitude and 78^0 37' to 78^0 46' E longitudes. The elevation of the watershed ranges from 605 m to 2278 m. The study was carried out using the method of Horton and Strahler, to rank the stream segments using ERDAS IMAGINE 9.1. The relevant numbers of the streams were entered into the attribute table and all other analyses based on the mathematical formulas. The results indicated that the watershed area is 131.43 km^2, The drainage Density ranges from 2.55 to 5.91, Stream frequency ranges from 3.65 to 13.13, Relief ratio ranges from 0.18 to 0.70, Ruggedness number ranges from 0.88 to 4.00 and Drainage texture ranges from 9.30 to 71.68. The results of this analysis would be useful in determining the effect of watershed characteristics such as size, shape, slope of the watershed & distribution of stream net work within the watershed.

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INTRODUCTION

Morphometry is the quantitative study of the characters of a drainage basin. A drainage basin is the area which contributes water to a particular channel or a set of channels. It is the source area of precipitation eventually provided to the stream channels through various paths. As such, it forms a unit for the consideration of the process determining the formation of specific landscapes (Leopold et al., 1964). Morphometry aims collecting data of the measurable factors of drainage basins which are subjected to statistical analysis and used in comparing precisely the characters of various individual basins. The main objective of this study, using advanced remote sensing and GIS technology is to compute basin morphometric characteristics for various parameters.

Study area

Geographically the catchment (Takoli Gad) is lying between the 30^0 14' to 30^0 23' N latitude and 78^0 37' to 78^0 46' E longitudes in the Survey of India toposheet No. 53 J/11, 53 J/12 and 53 J/15 with an area of about 131.43 Km^2. It comes under jurisdiction of district Tehri Garhwal, Uttarakhand. The area is approached by Kirtinagar-Tehri and Kirtinagar- Chauki all weather roads.

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The area falls in inner Garhwal lesser Himalaya and is characterized by gentle and mature topography. The Takoli Gad originates from the Eastern slope of the Chandrabadni Peak (2278 meter) and join the Alaknanda at Juyal Garh (605 meter). Jakhand and Dagar Gad are the two main sub streams / tributaries of the Takoli Gad watershed.

MATERIALS AND METHOD

The Morphometric analysis of Takoli Gad watershed have been carried out on the basis of a topographic map of study area, followed by relevant field checks supported by satellite data. Based on topographical map on 1:50,000 scales (Survey of India, toposheet No.- 53 J/11, 53 J/12, 53 J/15) the drainage map of Takoli Gad watershed has been prepared. Digitization work has been carried out for entire analysis of basin morphometry using GIS software (ERDAS IMAGINE 9.1). The streams of various orders (I^{st} to 6^{th}) were marked on the basis of Strahler's method (1952). Following parameters as suggested by Doornkamp and King (1971) were used for statistical analysis. The attributes were assigned to create the digital data base for drainage layer of the watershed. Various morphometric parameters such as linear aspects of the drainage network: stream order (Nu), bifurcation ratio (Rb), stream length (Lu) and areal aspects of the drainage basin: drainage density (Du), stream frequency (Fu), Drainage texture (Tu) of the basin were computed.

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Research Article

Geohydrology of Springs in a Mountain Watershed: A Case Study of Takoli Gad Watershed Garhwal Himalaya

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Abstract

Spring discharge is controlled by rainfall, land use, vegetation, grazing incidence and geomorphology of the recharge zone in a mountain watershed in Garhwal Himalaya. In the middle and greater Himalaya, natural springs are the main source of domestic water consumption, but their discharge does not remain constant with time. Erratic rainfall directly affects the recharging of the spring catchment. In this communication, the behavior of a perennial spring with rainfall variation is analyzed from two years data recorded seasonally i.e. winter, rainy, summer. The present work provides spring discharge pattern in a mountain watershed, explores interaction of spring behaviour with rainfall, landuse and other morphological characteristics of the springs, emphasizes water resource management.

Keywords: *Springs, Rain fall.*

Introduction

Water is an integral part of all facets of life, but its uneven distribution both in space and time comes in the way of development needs of the region. Despite the fact that the mountains provide life-giving water to millions of the downstream people through perennial river system. Springs are drying up or becoming seasonal and the difference in the volume of water flowing down the rivers during dry and rainy seasons is commonly more than 1000 times, resulting in too little and too much water syndrome, a common feature of the desert country. Studies indicates that the deforestation, landuse change, intense grazing, reduced water retention capacity of the catchments declining rainfall in some localities, etc. have led to diminishing discharge of the springs (Rawat, J.S. *et al*. 1994).

The recharging depands upon vegetational cover, in addition to the geological and geomorphological controls in the recharge zones. Geohydrological studies suggest that the lineaments produced by joints, fractures and faults play a very significant role on the hydrogeological regime of a catchment (Valdiya, K.S. *et al*. 1989, Valdiya, K.S. *et al*. 1991). Hydrological parameters, such as steam flow, runoff and interception loss, depend upon the amount and intensity of the rainfall, the density of tree crown and the branching pattern of tree (Ovington 1954, Rutter 1963, Raynolds and Henderson 1967, Dunne *et al*. 1991).

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Location of the area

Geographically the catchment (Takoli Gad) is lying between the 30^0 14′ to 30^0 23′ N latitude and 78^0 37′ to 78^0 46′ E longitudes in the Survey of India toposheet No. 53 J/11, 53 J/12 and 53 J/15 with an area of about 131.43 Km^2. It comes under jurisdiction of district Tehri Garhwal, Uttarakhand. The area is approached by Kirtinagar-Tehri and Kirtinagar- Chauki all weather roads. The area falls in inner Garhwal lesser Himalaya and is characterized by gentle and mature topography. The Takoli Gad originates from the Eastern slope of the Chandrabadni Peak (2278 meter) and join the Alaknanda at Juyal Garh (605 meter). Jakhand and Dagar Gad are the two main sub streams / tributaries of the Takoli Gad watershed.

Methodology

The monitoring of water discharge was conducted in three main seasons i.e. winter, summer and monsoon of 2007-2008. 12 springs in phyllite terrain and 3 springs in quartzite terrain of Takoli Gad watershed were selected for this study.

Location and Characteristics of Springs

Where the surface of the slope meets or intersect the water table, ground water moves out in the form of springs and seepage. Extensive field study in the area, was carried out to identify significant features of the spring zones.

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Rain Water Harvesting as Alternative in Water Scarcity Area: A Case Study of Takoli Gad Watershed, Garhwal Himalaya

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ABSTRACT: Water is the prime product of the forest and it is the basic human need which is felt more acutely in the drought condition being faced by the country. About 100 million people in 12 states of the country are facing sever water crises [11]. Even the basic need of two and a half liters of water per day for drinking purpose, has become difficult to meet in these states. The other effect of drought is loss of agriculture, fodder, water for cattle and migration of people and cattle from the area in search of water. Present study emphasis on the rainwater harvesting problem in Takoli Gad watershed. Most of the villages are located over the spurs on the both side of the Takoli Gad catchment, most of the villages are suffer from the acute shortage of water. Takoli Gad watershed carry very little amount of water in dry season.

KEYWORDS: Rain water harvesting

I. INTRODUCTION

Rain water harvesting is a generic term which includes all activities for collection of rainwater through an appropriate structure for using the stored water conveniently. Roof top rainwater harvesting is a special case of rainwater harvesting, water harvested from rooftop can be used directly for domestic consumption or, be stored as groundwater. In the hydrological cycle, rainfall is the entry point of fresh water on the surface of the earth. It is therefore, logical to catch the rain before it runs away [4]. The inhabitants of Takoli Gad watershed having facing acute shortage of water (drinking as well as other purposed used water) may also be solved by rainwater harvesting methods. Making of springs sanctuaries may also conserve the springs in the watershed. By these methods of rainwater harvesting the wasteland of this catchment may be converted in the forest land, which will be further helping in regeneration of springs & other source of water in the watershed.

Methodology: The methodology of this study confined to field observation, in depth interviews, sample collection, data presentation and analysis. For the better understanding of the site situation both primary and secondary data sources are used. In order to assess the appropriate water harvesting system, various formal and informal approaches are adopted in the field survey and data analysis. The location variation is analyzed by considering the physiography, climate, social structure and availability of materials for water harvesting systems. Community‟s idea and culture related to water harvesting system is analyzed carefully. The study is conducted during the period from January 2007 to December 2008.

Location of the area: Geographically the catchment (Takoli Gad) is lying between the 30^0 $14^{'}$ to 30^0 $23^{'}$ N latitude and 78^0 $37^{'}$ to 78^0 $46^{'}$ E longitudes in the Survey of India toposheet No. 53 J/11, 53 J/12 and 53 J/15 with an area of about 131.43 Km^2. It comes under jurisdiction of district Tehri Garhwal, Uttarakhand. The area is approached by Kirtinagar-Tehri and Kirtinagar- Chauki all weather roads. The area falls in inner Garhwal lesser Himalaya and is characterized by gentle and mature topography. The Takoli Gad originates from the Eastern slope of the Chandrabadni Peak (2278 meter) and join the Alaknanda at Juyal Garh (605 meter). Jakhand and Dagar Gad are the two main sub streams / tributaries of the Takoli Gad watershed.

RESEARCH ARTICLE OPEN ACCESS

Rural Transformation by Agriculture Diversification and Innovation Adoption: A study from Rudraprayag district, Garhwal Himalaya, India

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Abstract:

Rural communities in Garhwal Himalayan region face a range of socio-economic and environmental problems. The area of the present study is district Rudraprayag, Uttarakhand. This hill district has subsistence farming as their main economic activity. Due to subsistence livelihood, migration and a remittance based economy operate in the district. The potential of innovation/technology has not yet been adequately and appropriately harnessed to overcome the development constraints posed by the fragile Himalayan environment. As government made many efforts to boost the process of innovation adoption, the technologies currently restricted with only few progressive farmers. Thus, there is a need for agriculture diversification and large-scale extension of region specific technologies for enhancing the economic condition of rural poor/smallholder household. This study focuses on the issue of agriculture diversification, potential areas of diversification and need of diversification with the need of technological adoption.

Keywords - **Livelihoods, Capacity building, Technology adoption, Diversification**

1. Introduction:

The Himalayan regions are well known for its rich and varied natural bio-resources. However, recently the population pressures within the region leading to major changes in the environment and associated rapid reduction of natural resources. The economy of Uttarakhand is predominantly agrarian. More than 80% of the working population is directly engaged in agriculture even though only 12.5% of the total land area of Uttaranchal is under agriculture (Deolia *et al. 2009)*. Around 70% of the operational holdings of the hill region are less than 1 ha (census 1991). In addition, these land holdings are located in various sites and in the form of various fields. There is the geographical inequality between the hill and the plain regions of Uttarakhand, this geographical disparity marked itself in the form of inter-district inequality, which is the most acute in the areas of infrastructure like roads, electricity, irrigation and other necessary infrastructural facilities. The inter-district disparity in infrastructure leads to inequality in terms of income and livelihood between the hills and the plains, and results in rampant underdevelopment in the hills while the plains are relatively prosperous (Mittal *et al.* 2008). In order to transform

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Sustainability of Rural Livelihoods through Technology Adoption: A case from Rudraprayag district, Uttarakhand, India

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Abstract - *Most of the rural population of remote Himalayan region dependents on agro-based activities for their livelihood, but most of them threatened by the problems of unemployment and food insecurity. Although, government has made many efforts to achieve self sufficiency in food production, the growth of the agriculture sector has been stagnant in this hilly region. The development of rain-fed areas, whose potentials have not been fully exploited so far, needs to be developed to address these problems. The present need of the area is to promote self-employment to enable the rural poor to earn sustainable livelihood, while enhancing food production by utilization of waste lands, water harvesting etc. There is essentially a need to develop production in rain-fed areas with integration of livestock, value added crops and agro-forestry. This paper is based on field experience from 12 villages of Rudraparayag district, Garhwal Himalaya.*

Key Words: **Livelihood, Technology, Sustainability, Farming, Composting**

1. INTRODUCTION

India is one of the fastest growing economies in the world. But at the same time, the challenge before the country is how to ensure future growth in a sustainable and inclusive mode. It has various challenges in different nature in terms of employment, agriculture and rural development. Challenges have also been imposed by exclusive and inequitable access due to multiple deprivations of class, caste and gender. New technological approaches and solutions, and looking beyond the conventional mode of performing various tasks are required to solve these problems. New technologies could play a crucial role to ensure inclusion of vulnerable groups besides making the development environmentally sustainable.

The vast majority of farmers in developing countries are smallholders, with an estimated 85% of them farming less than two hectares [1]. These farmers mostly dependent on agro-based activities for their livelihood, but over 30 to 35% of them are threatened by the problems of unemployment and food insecurity. Hence, World Development Report (2008) emphasized that the potential of agriculture to contribute to growth and poverty reduction depends on the productivity of smallholder farmers. And raising that productivity will require a much higher level of adoption of new agricultural practices and technologies than presently observed in the smallholder farming population [2,1].

The methods described in this paper have been developed from a basic understanding of the way that different assets and activities contribute to peoples' livelihoods. This understanding builds upon the livelihood approach to consider the functions of assets (such as land and livestock) and activities (such as agriculture and livestock husbandry) within people's livelihood strategies.

2. STUDY AREA

The area of the present study is district Rudraprayag of Uttarakhand. The study area is situated in the north western part of the Garhwal Himalaya. The district covering an area of 2439 km^2, which lies between the latitude 30^{0}19' and 30^{0}49' North and longitude 78^{0}49' and 79^{0}21' East. The region contains diverse vegetation types due to different altitudinal gradient, ranging from tropical deciduous to temperate and subalpine forest. Forest and water is the most important natural resources of the district.

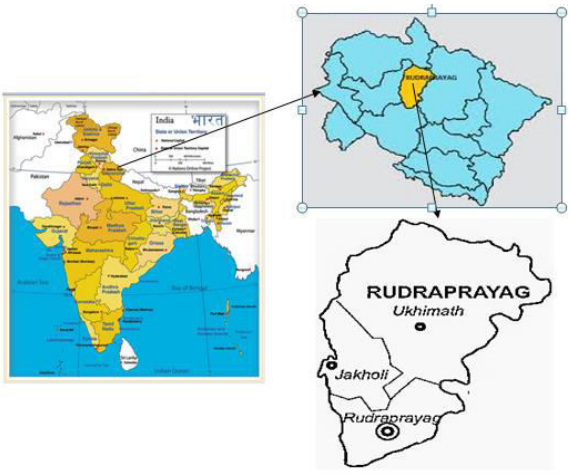

Figure-1: Map of the Study Area

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Research Article

Fuelwood Consumption by Villagers in Different Altitudinal Gradient: A Case of Takoligad Watershed of Garhwal Himalaya, India

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Abstract

The present study deals with the biomass use pattern by villagers along different altitudinal gradient during three seasons. Fuelwood used in watershed for different purposes such as cooking, boiling water and space heating. Preferred and commonly used species, emission of green house gasses due to combustion and alternative fuel sources were also examined. 69.33 % LPG (Liquid Petrolium Gas) was estimated in the study area but most of the families use LPG only for preparing tea during guest visit. Overall average fuelwood consumption (Kg/household/day) at three altitudinal zones in three different season was 6.58 in summer, 10.80 in winter and 6.52 in monsoon (Low 500-1000 m asl), 7.34 in summer, 12.72 in winter, 7.28 in monsoon (Middle 1000-1500 m asl) and 9.66 in summer, 14.42 in winter and 9.28 in monsoon (High 1500-2000 m asl). The sampled household complained of decline in the availability of fuelwood species in the nearby areas. The most preferred species for fuelwood were: Alnus nepalensis, Quercus floribunda, Pinus roxburghi, Rhododendron arboretum, Rhus purviflora and Toona ciliata. The information in this communication could be utilized for developing suitable region-specific and need-based alternative strategies for achieving sustainable fuelwood management at the micro-level.

Keywords: *Fuelwood consumption, Biomass, Bioenergy, Preferred fuelwood, Garhwal Himalaya*

Introduction

Biomass remained the principal component of rural domestic energy in India and most of the developing countries. A large part of the rural population in developing countries like India meet more than one third of their total energy demand, principally in the domestic sector (FAO, 2007; Vasudevan and Santosh, 1987; Natarajan 1985). Biomass accounts for approximately 14% of total energy used globally and is the largest energy source for the three-quarters of the world's population who live in developing countries. Among the various forms of biomass, fuelwood is the most attractive one and occupies a predominant place in the rural energy budget of the country (Kataki and Konwer 2002). Bioenergy is therefore nested at the intersection of three of the world's great challenges energy security, climate change, and poverty reduction and has received an enormous amount of attention in the past few years (FAO 2007). The scenario calls for proper biomass planning, especially in the Himalaya, as almost 90% energy demand is met with biomass resources (Sharma *et al.* 1999).

Fuelwoosd is the only source of energy for many people living in the mountains (Sundriyal and Sharma, 1996) because it is freely and easily accessible and simple to use (Blaikie, 1985). Commercial fuel is beyond the reach of the rural communities due to their poor socio-economic conditions (Kumar et al., 2009). Traditionally, people of the Himalayan region have been fulfilling their energy needs almost entirely from forests (Bhatt and Sachan 2004). According to one estimate, firewood accounts for over 54% of all global harvests per annum, suggesting a significant forest loss (Osei, 1993; Wahab *et al.*, 2008).

Due to an ever increasing population, fuelwood consumption is increasing rapidly in the watershed area. The intense use of forest resource, however, has put woody species in different regions of the world at risk (Dahdouh-Guebas *et al.*, 2000; Medeiros, 2011; Walters, 2005). The per capita annual consumption of dry wood in various parts of the Himalayas ranges between 500 to 1200 kg per capita per annum(Campbell and Bhattarai, 1984; Metz, 1990). This level of fuelwood consumption has resulted in over exploitation of natural resources; consequently, the Himalayan region is experiencing scarcity of fuelwood.

In Garhwal Himalaya, about 77.4% of the total human population is rural (Anonymous, 1991). Fuelwood that is collected from nearby forests is the only source of energy in this region (Bhatt and Badoni 1990). Commercial fuels are beyond the reach of most of the inhabitants, due to their poor socio-economic

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A study of physico-chemical parameters of springs around Srinagar Garhwal valley, Uttarakhand

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Abstract - **Spring water is the main source of water providing life to people in the mountain region especially in the Himalaya. Spring is a natural source of groundwater. Unlike wells, which may be owned and controlled privately; springs are generally community-owned and community-managed. Thus, they give a sense of a "common" resource i.e. groundwater shared through a common mechanism, i.e. the spring. The spring water samples were taken from the main water sources where maximum peoples were using them for drinking purpose. The present study was carried out on the physico-chemical analysis of 5 springs in district Pauri Garhwal of Srinagar Valley viz: Kolun dhara, Beega dhara, Kamleshwar dhara, Hanuman Mandir dhara and Kothar dhara. The samples were collected on monthly basis from March, 2012 to June 2013. The analysed various water parameters viz: Temperature, pH, Conductivity, Total hardness, Chlorides, D.O. and Nitrite. The results indicated that certain sources of water are suitable for drinking and other house hold consumption for the people of the region.**

Keywords - **Spring, Valley, hydrogeology, physico-chemical**

I. INTRODUCTION

The quality of water is a vital concern for mankind, since it is directly linked with human welfare. It is a matter of history that fiscal pollution of drinking water caused water born diseases which wiped out entire population of these cities. At present, the menace of water born diseases and epidemics still booms large on the horizons of developing countries. Polluted water is the culprit in such cases (Nollet, 2000).

Water is the most widely distributed and abundant substances found in nature. The irony is that our planet is a wash with water. In total, there is 1400 million billion liters of water, but most of this water is not used for drinking purpose, because 97% is sea water and only 3% is fresh water, out of which 2% is lidged in the polar ice caps and glaciers, only 1% water is available for portable use; whereas more water goes for irrigation than to drinking sanitation and all other uses (WHO, 2004).

Springs provide the main source of freshwater for drinking and other household consumption in the Indian Himalayan Mountains. People in rural areas of Uttarakhand primarily depend for drinking water on natural water sources such as springs. It also forms a main source of irrigation water in many parts of the mountain region. The mountain springs known as "Dharas"and "Naula". Springs occur where sloping ground and impermeable strata intersect with the ground water table. The water sources of such springs, in most of cases, are unconfined aquifers where the flow of water is under gravity. The objectives of the present study was to analyze the physicochemical parameters of drinking spring water samples collected around from the Srinagar valley of Uttarakhand.

Srinagar valley is located at 30.22°N 78.78°E at the left bank of Alaknanda river. It has an average elevation of 560 metres (1,837 feet). It is the largest city in the Garhwal Hills. Srinagar is the hottest place in the Garhwal Hills in summers as it is at low elevation of just 560 m. and the temperature reaches 45 °C on some days from May to July. It has chilly winters and the temperature can fall to 2 °C in December and January.

II. MATERIALS AND METHOD

The present study was carried out on the spring water quality of five springs of the Srinagar valley in district Pauri Garhwal, Uttarakhand namely; Kolun dhara, Beega dhara, Kamleshwar, Hanuman Mandir dhara, Kothar dhara. Water samples from the various locations of Srinagar valley were collected in clean 1 liter polythene bottles in the month of March 2012 to June 2013. Material requirement for sampling and analysis of water is sample containers, chemical and glassware, thermometer, tissue papers, other field measurement are, field note book, pen, pencil, markers, soap and towel, match box, spirit lamp, etc. All analysis was carried out as per APHA, Indian standard institute and BIS desirable limit for drinking water. Some material and methods are depicted as follows2:

1. Temperature is measured by the thermometer.
2. pH value: pH value in water is determined by pH meter.
3. Conductivity, D.O., in water is determined by the "EUTECH Instrument" of Cyberscan.
4. Total hardness: Hardness in water is determined by EDTA complexometric titration using EDTA solution, buffer solution, EBT indicator, disttilled water and titration apparatus etc.
5. Nitrate: Nitrate in water is determined by UV spectrophotometric method using spectrophotometer, nitrate free water, stock nitrates solution, standard nitrate solution, hydrochloric acid solution
6. Chloride: Chloride in water is determined by argentometric titration method using potassium chromate indicator solution, standard silver nitrate titrant, standard NaCl solution etc.

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Original Article

Fuelwood & Fodder Consumption Pattern in Uttarakhand Himalayan Watershed

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Abstract

This paper attempts to quantify the dynamics of seasonal fuel and fodder consumption in Takoligad watershed, Tehri Garhwal, Uttarakhand. The issues are more pronounced due to the lake of effective penetration of the alternative energy sources in the region. Data was collected at three altitudinal range during three seasons by randomly selecting 120 households of different villages. Data was analyzed by Friedman Test. It is observed that variation in fuelwood consumption exist at different altitudes in the hilly watershed. Domestic cooking is the major use of fuel wood in the entire watershed. Fuel wood consumption was highest 1091.35 kg capita^{-1} year^{-1} at higher altitudes and lowest 646.05 kg capita^{-1} year^{-1} in the middle altitudinal zone. The total annual consumption of fodder was highest (7946.05 kg) in high altitude and lowest (6077.25 kg) in the lower altitude villages. A study has been carried out to identify the fuel consumption pattern in rural areas of the watershed on pilot basis. The study reveals that the present level of use of fuelwood by households (95.2%) is continuing despite the fact that other fuels like kerosene, LPG are also being used.

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Keyword: Fuelwood, Dynamics, Deforestation, settlement, alternative sources

1. Introduction

In India, the majority of the population lives in the rural areas where fuelwood, crop residues and animal wastes provide most of the energy requirement. In Indian mountain villages fuelwood is the only main source of energy, supplying almost all of the cooking energy requirement. In India, about 70% of energy requirement is by the fuelwood, collected from the forests and nearby sites and about 50 million tons of wood are removed every year. Fuelwood has remained the principal component of rural domestic energy in India and most of the developing countries. Fuelwood collection and consumption are intricately linked to natural resource management. Demand for fuelwood from forests and commons causes resource degradation to the extent that collection exceeds sustainable yield. Deforestation, on the other hand, created a situation of fuelwood scarcity to the point that an impending "fuelwood crisis" looms in many settings [1,2]. Bio-energy can bring about other environmental benefits including the recovery of degraded land, reduction of soil erosion and protection of watersheds [3,4]. Availability of fuel, fodder and litter is important for the survival of the rural settlements since almost ninety percent of energy demand is met from the biomass in the Himalayan region [5].

Substitution from fuelwood to alternative sources of energy like biogas, kerosene and sun and wind power that do not affect natural forest, can reduce pressure on natural forests. In addition, more widespread use of improved stove, biogas and other improved end-use technologies through reduced energy input requirements also has the potential to reduce pressure on forest resources. Thus, a better understanding of the determinants of rural household's fuel substitution and adoption of improved energy conversion technologies is essential for informing forest policies and programs.

The watershed supports a variety of forest vegetation. In the upper zone of the watershed the natural vegetation is dominated by *Quercus leucotrichophora* (Banj) and *Rhododandron arboretum* (Burans) and middle and lower part of watershed is occupied by *Pinus roxburghii* (Chir), *Terminolia bellirica* (Bahera) and *Terminolia chebula* (Harda). Pine forests are spread over a greater part of the watershed. The regeneration of Oak forest in the study sites has been affected by severe anthropogenic pressure such as grazing, trampling, cutting of ground herbage, lopping of

Performance of MGNREGA to Poverty Reduction: Study in Pauri Garhwal District, Uttarakhand

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Abstract

The Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) to provide for enhanced livelihood security for households in rural areas by providing at least 100 days of guaranteed wage employment in every financial year to every household whose adult members volunteer to do unskilled manual work. As a legal right to work, MGNREGS contrast with previous employment- generation schemes in several aspects. The purpose of the study is to analyze the performance of Mahatma Gandhi National Rural Employment Guarantee Act in district Pauri Garhwal of Uttarakhand state. However, the paper finds large women participation under this scheme; highest number of assets is created in the area of rural connectivity and few in drought proofing.

Keywords: Assets, Employment, Mgnrega, Performance, Poverty.

I. INTRODUCTION

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), the flagship welfare programme of India was passed by the Parliament in August 2005 and came into effect on 7th September 2005. Under this Act, every adult member of any rural household who is willing to do unskilled manual work have a legal right to get 100 days in a financial year at the statutory minimum wage. The law was initially called the NREGA (National Rural Employment Guarantee Act) but was renamed as the MGNREGA on 2nd October, 2009 on the eve of the birth anniversary of the Father of Nation, Mahatma Gandhi. It brings a path breaking legislation that provides a social safety net to the poor people in India.

On February 2, 2006, the MGNREGA came into force in 200 most backward districts of India (Known as Phase I districts) formally launched at Bandlapalle village in Ananthpur District of Andhra Pradesh. It was further extended to 130 additional districts w.e.f. 1st April 2007 (Known as Phase II districts) making a total of 330 districts under the act. The Act has been universalised w.e.f. 1st April 2008 to cover all the remaining backward districts in the country except the districts that have hundred per cent of urban population (NREGA, 2008). It is found as one of the world's largest public employment guarantee programme to give the right to employment to every rural household.

In Uttarakhand, the scheme was initially launched in 3 districts i.e., Chamoli, Champawat and Tehri in 2006-07 (Phase-1). In second phase (2007-08), two additional districts, i.e., Haridwar and Udhamsingh Nagar were added. In the last phase, all the remaining districts have been notified under the scheme. MGNREGA was applied to district Pauri Garhwal in the third phase and the implementation of MGNREGA scheme in the district commenced on April 1, 2008. The purpose of the study is to analyze the performance of MGNREGA in Pauri Garhwal district of Uttarakhand state.

II. REVIEW OF LITERATURE

As the scheme is ongoing from 2006 onwards, various attempts have been made to analysis the performance of MGNREGA. Das (2013) evaluates the National Rural Employment Guarantee Scheme (NREGS) according to criteria viz. average number of days of employment per household; percentage of households completing 100days of employment under NREGS; percentage of expenditure against total available funds etc. Performance across the first two criteria has been disappointing and has deteriorated over time. Percentage of expenditure against total available funds has risen sharply. Finally, it is difficult to escape the

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Original Article

Physico-chemical Study of Springs: A Case Study of Muchlad Gad Watershed Garhwal Himalaya, Uttarakhand, India

Santosh Singh , R.S. Negi , Rekha Dhanai and M.K. Parmar

ABSTRACT

The present study was carried out on the physico-chemical analysis of 12 natural springs in the Muchlad Gad Watershed District Pauri Garhwal, Uttarakhand, The samples were collected on seasonal basis (summer, rainy and winter) during 2010-2011. The analyzed various water parameters viz: Temperature, Discharge, pH, Conductivity, Alkalinity, Total hardness, Chlorides, and Nitrite. The results indicated certain sources of water are not polluted and suitable for drinking and other purpose.

Keywords:
Garhwal Himalaya, Physico-chemical, Spring, Watershed.

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Introduction

A watershed is an ideal unit for management of natural resources like land and water for achieving sustainable development. Watershed is defined as all the land and water areas which contribute runoff to a common point. A watershed is a geo-hydrological unit, which drains at a common point. The watershed above any point on a defined channel is therefore all the land and water areas which drain through that point (often the outlets). Watershed boundaries define the aerial extent of surface water drainage to a point. Watershed boundaries always follow the highest ridgeline around the stream channels and meet at the bottom or lowest point of the land where water flows out of the watershed. Every bodies of water viz., rivers, lakes, ponds and streams and a watershed. The boundary between watersheds is defined as the topographic dividing line from which water flows in two different directions. Watershed is marked by an elevated line (divide line) that forms a division between two areas drained by separate streams, river systems or lakes (Tidemann 1996).

Water is essential for the survival of humans, animals and plants. Fresh water is emerging as one of the most critical natural resource issues facing humanity. Water is, literally, the source of life on earth. The human body is 70% water. Human beings can survive for only a few days without fresh water. The quality as well as the quantity of water is deteriorating globally as a result of rapid urbanization, population growth and industrialization. Most countries however currently are aware of the necessity of fresh water as a requirement for survival. Fresh water needs to occupy highest priority, on the international agenda Scarce and unclean water supplies are critical public health problems in much of the World. Polluted water, water shortages, and insanitary living conditions kill over 12 million people a year (Davidson et al, 1992).

Springs provide the main source of freshwater for drinking and other household consumption in the Indian Himalayan Mountains. People in rural areas of Uttarakhand primarily depend for drinking water on natural water sources such as springs. It also forms a main source of irrigation water in many

The Effects of Climate Change on Natural Resources and Socio-economic Condition of Himalayan Communities of Uttarakhand, India

Rekha Dhanai, R.S Negi, Santosh Singh, M.K. Parmar

Abstract— **Climate change is one of the most important environmental challenges that affect all the natural ecosystem of the world. This article provides a brief overview of climate change impacts on agriculture, water and forest ecosystems in the Uttrakhand Himalayan mountains based on the available literature and some anecdotal evidences of the local people and researchers. Number of studies has been carried out on various aspects of Himalayan ecosystems, however, only a few local studies has been available dealing with the climate change related aspects, primarily due to lack of systematic and focussed associated data. Therefore, the qualitative analysis reveals that there is an urgent need to strengthen climate data collection network to meet the requirement of researches on various aspects of climate change impacts, mitigation and adaptation. The synthesis reveals that the climate change impacts at local level also need to be categorized based on various climatic elements viz., rainfall, temperature, CO_2 concentration, including their cumulative responses. The use of sophisticated instruments and modern technologies with top down approach must be adopted, so that the research findings may be dove-tail with the people oriented policies. Coordinated efforts are required for adaptation and mitigation as the vulnerable mountain ecosystems and communities are likely to face greater risk of climate change impacts than other ecosystems due to their high synergy with respect to each other. Capacities of communities have to be enhanced and strategies are to be developed for adaptation to climate change at one hand and on the other several climate resistant tailor made technologies need to be promulgated and developed.**

Index Terms— **Ecosystem, Hydropower, Climate-sensitive, Livelihood, Glacier.**

I. INTRODUCTION

Climate change refers to changes in the earth's climatic conditions occurring over a period of time, either due to natural forces or from human activities. Climate change is a major challenge facing our planet today. Climate and natural ecosystems are closely related and depend on each other, and the stability of this relation is an important ecosystem service. This is an all encompassing threat that will pose significant environmental, economic, social and political challenges for years and decades to come. Exponential increase in green house gases (GHGs) like carbon dioxide, methane, nitrous oxide, CFCs, etc., in the atmosphere has resulted in Climate change [1]. The concentration of CO2, mainly responsible for global warming, has reached to 379 ppm in 2005 from its pre-industrial value (i.e., 280 ppm) [2]. The increase in GHGs between 1970 and 2004 was approximately 70%. The mean temperature of the earth has increased by 0.74ºC during last century [1]. The review report [3] projecting the scenarios of global warming indicate that the global average surface temperature could rise by 1.4 to 5.8°C by 2100. Globally, the sea level rose at the rate of 1.8 mm year^{-1} during 1961 to 2003, and faster (i.e., at the rate of 3.1 mm year^{-1}) during 1993 to 2003 and global mean sea level is projected to rise by 0.18 to 0.59 m by the end of the current century [2]. Climate change has emerged as a global environmental issue that has engaged the world attention as it relates to global common atmosphere. It is scientifically least predictable, and its impacts are likely to affect adversely the vulnerable and poor people mostly, who have contributed least to the major causes of Climate Change. Mountains are early indicators of climate change [4]. As glaciers recede, and snowlines move upwards, river flows are likely to change, and alteration in water flow regime may lead to a plethora of social issues and affect hydropower generation, endanger biodiversity, forestry and agriculture-based livelihoods and overall well-being of the people. The Indian Institute of Tropical Meteorology, Pune has reported a decrease in precipitation over 68 per cent of India's area over the last century [5].

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II. SOCIO-ECONOMIC IMPACTS OF CLIMATE CHANGE

Himalayan mountains are considered highly vulnerable to climate change, not only because of high physical exposure to climate-related disasters but also because of the dependency of its economy on climate-sensitive sectors (e.g. agriculture, forests, tourism, animal husbandry, fisheries etc.). Specific knowledge and data on human wellbeing in the Himalaya is limited, but effects of Climate change will be felt by people in their livelihoods, health, and natural resource security, among other things [6]. Poverty, poor infrastructure (roads, electricity, water supply, education and health care services, communication, and irrigation), reliance on subsistence farming and forest products for livelihoods and other indicators of development make the Himalaya more vulnerable to Climate change as the capacity to adapt is inadequate among the inhabitants [2]. Climate change has a significant impact on human health by directly or indirectly. Direct impacts of climate change on human health could include: Exposure to thermal extremes (cardiovascular and respiratory diseases) and altered frequency or intensity of other weather events – leading to injuries, psychological

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Full Length Research Paper

Implications of GIS Application for the Sustainable Watershed Development in Garhwal Himalaya: A Case study of Takoli Gad Watershed, District Tehri Garhwal, Uttarakhand

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Abstract

Using Geographic Information System (GIS), Takoli Gad Watershed was studied for optimizing the present utilization of natural resource, land use, slope stability, infrastructure distribution and socio-economic status. Remotely sensed data is use to make decision and cross examine the watersheds that have contrastingly different setup, currently undergoing deforestation due to unsustainable human activities. ERDAS IMAGINE 9.1 was used for generating thematic maps and these were superimposed on different combinations for delineating the final output. The thematic maps are used for decision support and planning of the watershed. One of such remedial measure for the target area, were currently soil erosion and consequent slope instability vulnerability exists, soil conserving plants species have been recommended. The high rate of gully erosion and active river network was attributed to local geological conditions that host highly fractured and weak lithology type. The morphometric analysis has also been done to determine the role of external forces on the landform.

Key words: *GIS, Watershed Development*

Introduction

The integrated approach of Geographical Information System (GIS) and Remote Sensing is now being recognized universally as unique, highly effective and extremely versatile technology for evaluation, management and monitoring of natural resource and socio- economic database. It is a computer setup that makes it possible to view and analyze data in the form of digitized maps. GIS technology is increasingly being put in spatial decision support systems and its utilization extends from risk assessment for calamities, natural resources development, and infrastructure development to various geological studies (Saraf, 1997). In this paper GIS, as a tool in the development and measurement of watershed, is discussed with the example of a pilot studies conducted for Takoli Gad watershed.

Watershed basically for this purpose is delimited by the catchment area of the stream. Stream order systems are analyzed with the size and shape of the stream segments. The size and shape of every stream segment varies depending on physiography and anemohydrographic structure (Saxena, 1997). Hence, mostly third to fifth order stream in the watershed are treated as micro level watersheds. The present paper tries to bring out the application of integrated GIS planning and development for the watershed through the case study of Takoli Gad watershed.

The Study Area

Geographically the Takoli Gad watershed lies between 30^0 14' to 30^0 23' N latitude and 78^0 37' to 78^0 46' E longitudes in the Survey of India toposheet No. 53 J/11, 53 J/12 and 53 J/15. The watershed has an area of about 131.43 Km^2 and comes under jurisdiction of district Tehri Garhwal, Uttarakhand. The area falls in inner Garhwal lesser Himalaya and is characterized by gentle and mature topography. The Takoli Gad originates from the Eastern slope of the Chandrabadni Peak (2278 meter) and join the Alaknanda at Juyal Garh (605 meter). Jakhand and Dagar Gad are the two main sub streams / tributaries of the Takoli Gad watershed.

Methodology

The thematic maps of Takoli Gad watershed has been prepared based on Survey of India Topographic maps on the scale of 1:50,000. All the maps like location, drainage, stream order, slope, geology, geomorphology, landuse have been prepared and digitized by the help ERDAS IMAGINE 9.1. The primary data were collected for developing socio-economic database are: Demography, Occupational structure, Landholding/Livestock, Developmental activities, Education,

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Full Length Research Paper

Landslide Hazard Zonation using Remote Sensing and GIS: A Case Study of Giri Valley, District Sirmaur Himachal Pradesh

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ABSTRACT

The Himachal part of extra-peninsula that has been compressed about 65% and resulted in the orogenesis to form very steep mountain range. The structural disturbances like folding, faulting and shearing are very common in this region. Slopes, deforestation, heavy precipitation and the road construction itself have found to be the main cause of slope instability. This area exhibits varieties of landslide movements. In the present work the attempt has been made to create the Landslide Susceptibility or Hazard Zonation Map along with some predictive locations with the help of Remote Sensing data and the GIS layers mainly DEM, slope maps, and flow accumulation maps in small area in the Giri river valley in Sirmaur district of Himachal Pradesh. The areas are structurally disturbed and lie in seismic zone IV and receive very high precipitation. It has been confirmed that the slide prone sites mapped by flow accumulation, lithology and slope maps were really the landslide hazard zones with typical slope instability and many pre occurred slides have been observed on the color composite of the satellite imagery. In the present work, the effort has been made to make the land slide susceptibility zonation map by using the integrated geoinformatics along with the information value technique. Various generated rasters were given the experience based weightage and analysis was made in the GIS environment to prepare the final landslide susceptibility zonation map.

Key words: *GIS, Information value technique, Integrated geoinformatics Landslide, Susceptibility, Zonation,*

INTRODUCTION

In many regions of the world a temporary instability of superficial mass of soil and rock has always been an acute problem. These superficial masses may leave their original positions abruptly or extremely slowly and start either a downgrade movements or vertically downward sinking thus giving rise to baffling situation. These movements of the ground may entail loss to property and life, especially when they happen to occur in or near the populated areas, along highway, railway lines, dams and reservoirs, tunnels or under heavy structures. Such movements of the superficial masses have been termed in common man language as landslides or landslips. In technical language, however, these have been grouped as mass movements and form a major subject of study for geologist and a remote sensing expert concerned with the design making regarding stability of slopes.

The term landslide describes a wide variety of processes that result in the movement of slope forming materials including rock, soil, artificial fill, or a material may move by falling, toppling, sliding, spreading or flowing. Landslide is the movement of a mass of rock, debris or earth down a slope.

Landslides may be ignored if they occur in uninhabited places and places of no human interest. But, if they occur in places of importance such as highways, railway lines, valleys, reservoirs, human inhabited areas and agricultural lands, obviously such instances lead to blocking of traffic, collapse of buildings, harm to fertile lands and so on apart from heavy loss of life and property. It is very common in the Himalayan region that is geodynamically active. Being the youngest mountain system of the world, it constitutes a fragile ecosystem of unstable slopes with a major geo-hazard of landslides.

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GEOHYDROLOGICAL STUDIES OF THE SPRINGS AND STREAM WATER: A CASE STUDY OF TAKOLI GAD WATERSHED, GARHWAL HIMALAYA

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ABSTRACT

Water is an integral part of all facets of life. It is a key element in the socio-economic development of the country as a whole, and is particularly of critical importance to the Himalayan region. For the 250 million people living on the valley floors and plateau areas of the Himalayas net lands are central to their livelihoods. Lakes flood plains and peat land support agriculture and industry in these areas. Rice cultivation, grazing fish farming, collecting fuel and building materials and tourism together with local spiritual and religions activities are vital to the regions poorest communities. The one and half billion people in low land regions depend on services provided by high altitude water bodies. Water is an important integrated component for land use decision. As a matter of fact too much and too little water syndrome in the mountains (Valdiya et al.1993) posses serious limitation of the desired land use. In many localities people face various magnitudes of water scarcities, even for drinking (Negi & Joshi 1998). Present study attempts the geohydrological studies of springs and stream water of Takoli Gad watershed, which is a sixth order stream of the river Alaknanda, one of the major snow fed river of the Ganges system. Takoli Gad watershed is located in lesser Himalayan zone, which is constituted by phyllite, quartzite, metabasisc, slates and carbonates of Garhwal Group.

Key words: Physical parameter, chemical parameter, water discharge.

INTRODUCTION

All types of natural waters are rich in bacteria, algae, worms and other organisms and the composition of natural waters varies with time and season (Drever, 1982). Settable solids of mineral and organic origin, generally settle under gravity and their concentration in water changes with time. Some of the organic are destroyed by micro-organism present in water which change its composition