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RESEARCH ARTICLE

MOISTURE CONTENT AND ITS ANNUAL VARIATION IN TEMPERATE CONIFEROUS FORESTS OF KASHMIR HIMALAYA

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ABSTRACT

The soil moisture is regarded as indicator of climate change. The temperate forest has great relation with moisture content which showed variation with altitude, seasons and depths. The seasonal variation of moisture depends upon the precipitation comes from. Kashmir Himalaya has snow the main source of precipitation which adds moisture to the forest ecosystem by melting it with increase in the temperature of the area. The seasonal variation of moisture content and its annual variation were studied and the results revealed that Daksum has highest moisture content than corresponding ranges both among range wise and depth wise and dominated among all the three seasons of the year. Surface layer of forest has maximum moisture than subsurface layers during all the seasons. Daksum showed positive increment during autumn and summer season while negative during spring. The results conclude that spring season showed highest moisture content than summer and winter. All the results were subjected to ANOVA and the results were found significant at $p<0.05$ level of significance.

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INTRODUCTION

The output of temperate forest ecosystem is rigorously controlled by availability of water, lack of which may have great impact on density of vegetation particularly trees. Moisture has important role in continuity of soil-tree atmosphere because with the help of the same the nutrients gets available for proper functioning of the physiological process of the plants which helps in regulating the forest ecosystem, thus maintains an important ecosystem service which directly mitigates the atmospheric carbon dioxide. Carbon dioxide flux gets decreased by increasing drought, due to which limited growth of trees would happen, thus survival of ecosystem may become a serious issue (Poole, 1981). Drought cause decrease in leaf area index in temperate forests (Battaglia *et al.,* 1998; Le Dantec, 2000) thus results in decline of gross primary productivity (Law *et al.,* 2002). Due to change in global scenario it is expected enhancement of drought in various regions especially in Northern Hemisphere (IPCC, 2001; Salinger, 2005; Saxe 2001; Schar, 2004). The ecosystem is sustained by mutual transfer of energy between various tropic levels viz. Producers, consumers and decomposers (Prescott *et al.,* 2004). Major part of the energy comes in the form of fallen material as litter (Xu and Hirata, 2005) which upon decomposition due to moisture becomes an active source of energy in the form of organic matter and provides nutrients for the sustainability of plant (Christensen, 1975). Decomposition of litter leads to nutrient cycling and soil formation (Yu *et al.,* 2005; Rawat *et al.,* 2010). Soil moisture content varies due to inflow of precipitation and snow melt while outflow results in water uptake by roots, evaporation by plants as well as physical evaporation and leaching of water to deep depth not available to the plant. This all occurs due to seasonal variation as well as various natural parameters like weather. Variation of soil moisture can occur due to texture of soil, vegetation, litter density, root system, and geographical variability (Wilson *et al.,* 2000; Griffiths *et al.,* 2009; Xu *et al.,* 2013; He *et al.,* 2014). The management and understanding of forest ecosystem is critical with maximum population of world depending on these forests in the form of various ecosystem services (McElrone *et al.,* 2013). Different workers relate various parameters and their dependence on tree density among which precipitation is major one (McKenney-Easterling, 2000). Soil water balance and plant water relation has been effected by change in carbon dioxide (Schafer *et al.,* 2002). The soil moisture is regarded as indicator as well as driver of environmental change, understanding of which is critical phenomenon (Asbjornsen *et al.,* 2011; Peng *et al.,* 2013). Global temperature is increasing and warming the environment continuously thus, temperature change and precipitation showed variation in the growing season (Duran *et al.,* 2014), which effects the structure and function of terrestrial ecosystem

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(Butler *et al.,* 2012). Soil warming can change nutrient cycling which directly impacts on climate change (Peterjohn *et al.,* 1994; Rustad *et al.,* 2001; Butler *et al.,* 2012 Melillo *et al.,* 2011, Butler *et al.,* 2012; Auyeung *et al.,* 2013). Himalayas are considered youngest among all the mountain ranges of the world, consists mostly of sedimentary and metamorphic rocks, occupies 16.2% of the total geographical area and spans over 12 states of the country (Dar and Somaiah, 2013). The Himalayas in India are categorized into Northern Himalaya, Western Himalaya, Central Himalaya and North-eastern Himalaya (Nautiyal *et al.,* 2005). The geographical area of the Jammu and Kashmir state is 10138 sq. km and from which 20230 sq.km are under forest cover (Dar and Somaiah 2013). Western Himalayas showed great variation in temperature and moisture because the precipitation mostly comes in the form of snow during winter which melts with increasing temperature and adds moisture to the ecosystem. Hence current work was carried out to assess the annual variation of moisture during different seasons of the year.

MATERIALS AND METHODS

Description of the Study Area

The study was carried out at four sites (Ranges) of Anantnag Division Viz Daksum, Pahalgam, Kokernag and Kuthar with coordinates, (Pahalgam Latitude 33°57′08.3N Longitude 75°18′43.4E, and Daksum Latitude 33 ° 34′43.1N Longitude 75 ° 23′17.2E, Kuthar Latitude 33 ° 34′43.1N Longitude 75 ° 23′17.2E and Kokernag Latitude 33 ° 34′43.1N Longitude 75 ° 23′17.2E). The study sites shows variation in altitude with Pahalgam 2090 msl, Daksum 2293 msl, Kuthar 2016 msl and Kokernag 2029 msl. Influence of local people, tourism, and forest management were also taken into consideration during research work.

Sampling Techniques on the Field

Simple random sampling method was used to take samples. During sampling various factors were taken into consideration like seasonal variation, protected or opened type, and altitudinal variation of the study area. Eight permanent quadrats of (20 m x 20 m) in each range were established and the sampling was done at various depth (10 – 30 cm). Composite soil sample were taken for laboratory analysis. Sampling was done on seasonal basis viz. autumn, spring and summer from 2014 to 2016.

Determination of moisture content

Gravimetric Method (Kadam and Shinde 2005) was used for estimating the soil moisture content which is very easy and simple method to operate. The soil of fresh samples of 50 gm weight was placed in the moisture box and weighed on digital balance after placing the lid. The soil samples were taken to laboratory and kept in hot air oven at 100 degree. The samples were reweighed till constant weight was attained.

Statistical analysis

The statistical analysis used to test the significant differences among different species was done by applying analysis of variance (ANOVA) using sigma stat 3.5. Normality test and equal variance test were also applied following, Student-Newman-Keuls range test to examine the difference at significance level of $p<0.005$.

RESULTS

Soil moisture content variation during autumn season

All the ranges and seasons for various depths were studied for soil moisture content and the results revealed that Daksum has highest moisture content than corresponding ranges both among range wise and depth wise. At 10 cm depth highest variation was found at Daksum with annual enhancement of 0.82% followed by Kuthar 0.76% and Pahalgam 0.73%. Kokernag showed decrement in annual variation with -0.73%. At 20 cm depth Daksum and Pahalgam showed positive variationt with 0.7% and 0.64% while Kokernag and Kuthar showed negative variation with -0.6% and -0.68%. At 30 cm depth all the ranges showed negative variation in soil moisture content with -.63%, -0.6%, -0.69% and -0.68% at Daksum, Pahalgam, Kokernag and Kuthar respectively. The variation among different range wise was found significant at $P<0.05$ by following ANOVA.

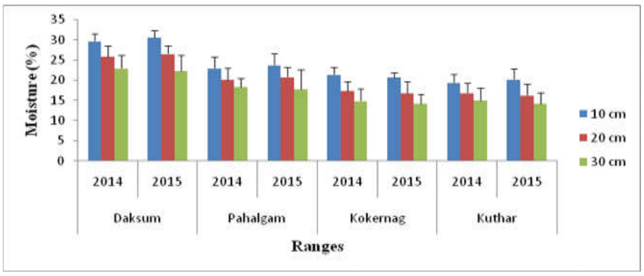

Figure 1. Variation of moisture at different ranges with depth during autumn season (mean ± within SD)

Soil moisture content variation during spring season

During spring season same trend of autumn season was followed with Daksum dominating the area both among range wise and depth wise followed by Pahalgam, Kokernag and Daksum. At 10 cm depth Kokernag showed positive variation with annual increment of 0.99% while Daksum and Pahalgam showed negative variation from 2015 to 2016 of spring season, Kuthar showed no variation on annual basis. At 20 cm depth Daksum and Kokernag showed Positive variation with increment of 1.13% and 0.82% while Pahalgam and Kuthar showed decrement in annual variation with -0.81% and -0.99%. At 30 cm depth similar trend was followd as in 20 cm with Daksum and Kokernag showing positive variation with increment of 1.03% and 0.76% while Pahalgam and Kuthar showed negative variation with -1.67% and –0.84% respectively. Significant difference was found at $P<0.05$ among different ranges of the study area.

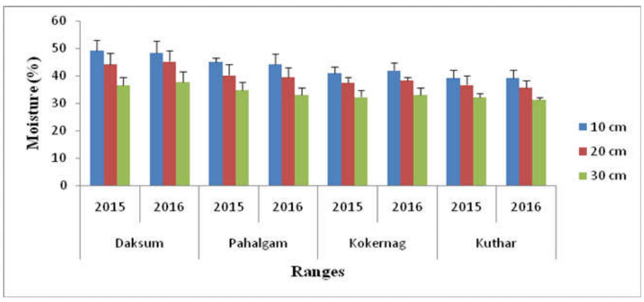

Figure 2. Variation of moisture at different ranges with depth during spring season (mean ± within SD)

Soil moisture content variation during summer season

During summer season Daksum has highest moisture content in both years while Kuthar has lowest. With depth wise moisture content decreases with increasing depth. At 10 cm depth Daksum, Pahalgam and Kokernag showed positive variation of 1.04%, 0.84% and 0.84% while Kuthar showed negative variation of -0.75%. At 20 cm depth only Daksum showed positive variation with 0.92% while Pahalgam, Kokernag and Kuthar showed negative variation with -.6%, -0.81 and -0.71% respectively. At 30 cm depth again Daksum showed Positive increment with 0.79% and remaining ranges showed negative variation in which Pahalgam has 0.74%, Kokernag -0.64% and Kuthar -0.69% respectively. The results were found statistically significant at $P<0.05$ among different depths and ranges.

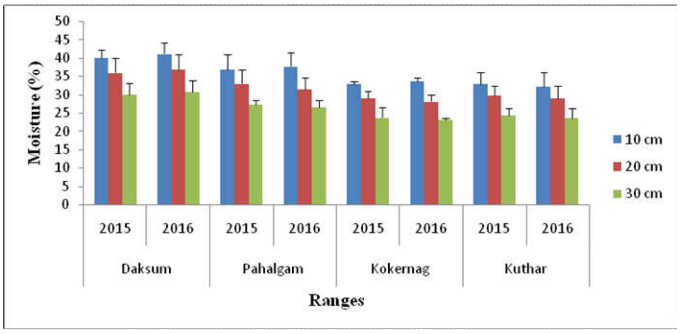

Figure 3. Variation of moisture at different ranges with depth during summer season (mean ± within SD)

DISCUSSION

The results of moisture content on seasonal basis revealed that spring showed highest moisture content followed by summer and autumn. The reason of having highest moisture content in Kashmir Himalaya during spring season was that the winter remains covered with snow and with onset of spring season the snow starts melting which adds the moisture to the soil during spring season while during summer and winter the moisture content gets decreased which are revealed from the current findings. Daskum showed highest moisture during all the seasons due to higher elevation. The higher elevation can have cooling effect which adds moisture to the soil and the same observations were carried out by previous workers (Griffiths 2009), while observing moisture at different altitudes. Pahalgam followed Daksum in elevation and the moisture content has the same trend thus with decreasing altitude from Daksum to Kuthar moisture content also showed variation with same trend. With increasing depth the moisture content decreases in all the ranges and in all the seasons. The decreasing trend of moisture content was also showed by (Dar *et al.,* 2015) while working in temperate coniferous forests of northern Kashmir and the range of moisture was also in accordance with the current results thus the worker supports the current findings. Similar results of soil moisture along with depth were observed (Joshi and Negi, 2015; Dar and Somaiah, 2013) which again support the results. The same workers were found that during wet conditions the moisture was highest and in current study spring has highest moisture in the soil thus are in accordance with current results. The negative variation was found at 30 cm depth which may be due to the growing atmospheric conditions which has impact on subsurface layers resulting in dryness.

Conclusion

Moisture has an important parameter in regulating various activities of forest ecosystem and showed variation among different ranges as well as different depths. Highest moisture content was found at Daksum which is at higher altitude and lowest at Kuthar. Surface layer of soil showed maximum moisture content than subsurface layers. All the ranges showed increment at surface layer of soil among all the seasons while subsurface layers showed decrement except Daksum range. Spring season has maximum moisture content followed by summer and winter. This clearly indicates that moisture content decrease with increasing time at subsurface layers which may has consequences on forest vegetation. Thus during the course of time variation in climatic conditions results in decrement of moisture.

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REFERENCES

Angeles G, Bond B, Boyer JS, Bodribb T, Burns MJ, Cavender-Bares J, Clearwater M, Cochard H, Comstock J, Domec JC, Donovan L, Ewers F, Gartner B, Hacke U, Hinckley T, Holdbrook NM, Jones HG, Lopez-Portillo J, Lovisolo C, Martin T, Martinez-Vilalta J, Mayr S, Meinzer FC, Melcher P, Mencuccini M, Mulkey S, Nardini A, Neufeld HS, Passioura J, Pockman WT, Pratt RB, Rambal S, Richter H, Sack L, Salleo S, Schubert A, Schulte P, Sparks JP, Sperry J, Teskey R, Tyree M 2004. The Cohesion-Tension Theory. *New Phytol.*, 163: 451–452.

Asbjornsen H, Goldsmith GR, Alvarado-Barrientos MS, Rebel K, Van Osch FP, Rietkerk M, Chen J, Gotsch S, Tobon C, Geissert DR, Gomez-Tagle A, Vache K, Dawson TE. 2011. Ecohydrological advances and applications in plant–water relations research: a review. *J Plant Ecol.,* 4:3–22.

Auyeung DS, Suseela NV and Dukes JS 2013. Warming and drought reduce temperature sensitivity of nitrogen transformations. *Glob Chnge Biol.*, 19:662-676.

Battaglia M, Cherry ML, Deadle CL, Sands PJ, Hingston A. 1998. Prediction of leaf area index in eucalypt plantations: effect of water stress and temperature. *Tree Physiol.*, 18: 521–528.

Butler SM, Melillo JM, Johnson JE, Mohan J, Steudler PA, Lux H, Burrows E, Smith RM, Vario CL, Scott L, Hill TD, Aponte N and Bowles F. 2012. Soil warming alters nitrogen cycling in a New England forest: implications for ecosystem function and structure. *Oecologia,* 168: 819-828.

Christensen T. 1975. Wood litter fall in relation to abscission, environmental factors and the decomposition cycle in Danish Oak forest. *Oikos*, 26: 187–195.

Cruiziat P, Cochard H, Ameglio T. 2002. Hydraulic architecture of trees: main concepts and results. *Ann For Sci.,* 59:723– 752.

Dar AW, Pathak B and Fulekar MH. 2015. Assessment of soil organic carbon stock of Temperate Coniferous Forest in Northern Kashmir. *Intl Jnl of Envt.*, 168 -171.

Dar JA and Somaiah S. 2013. Altitudinal variation of soil organic carbon stocks in temperate forests of Kashmir Himalayas, India. *Entl. Monig. Asst.*, 187: 1-11.

Durán J, Morse JL, Groffman PM, Campbell JL, Christenson LM, Driscoll CT, Fahey TJ, Fisk MC, Mitchell MJ and Templer PH. 2014. Winter climate change affects growing-season soil microbial biomass and activity in northern hardwood forests. *Glob Chnge Biol.,* Doi: 10.1111/gcb.12624.

Goldstein AH, Hultman NE, Fracheboud JM, Bauer MR, Panek JA, Xu M, Qi Y, Guenther AB, Baugh W. 2000. Effects of climate variability on the carbon dioxide, water, and sensible heat fluxes above a ponderosa pine plantation in the Sierra Navada (CA). *Agric For Meteorol.*, 101:113–129.

Griffiths RP, Madritch MD, Swanson AK. 2009. The effects of topography on forest soil characteristics in the Oregon Cascade Mountains (USA): implications for the effects of climate change on soil properties. *ForEcolManag.,* 257:1–7.

He L, Ivanov VY, Bohrer G, Maurer KD, Vogel CS, Moghaddam M. 2014. Effects of fine-scale soil moisture and canopy heterogeneity on energy and water fluxes in a northern temperate mixed forest. *Agric For Meteorol.,* 184:243–256.

IPCC Climate change 2001. the scientific basis.

Joshi G, and Negi GCS. 2015. Physico-chemical properties along soil profiles of two dominant forest types in Western Himalaya. *Current Sci.*, 109: 798-803.

Kadam JR, Shinde PB, Practical Manual on Soil Physics – A method manual, Department of Agricultural Chemistry and Soil Science, P.G.I., Rahuri, P-59.

Law B, Falge E, Gu L, Baldocchi DD, Bakwin P, Berbigier P, Davis KJ, Dolman AJ, Falk M, Fuentes JD, Goldstein AH, Granier A, Grelle A, Hollinger D, Janssens IA, Jarvis PG, Jensen NO, Katul G, Mahli Y, Matteucci G, Meyers T, Monson RK, Munger JW, Oechel W, Olson R, Pilegaard K, Paw UKT, Thorgeirsson H, Valentini R, Verma S, Vesala T, Wilson K, Wofsy S. 2002. Environmental controls over carbon dioxide and water vapour exchange of terrestrial vegetation. *Agri For Meteorol.*, 113: 97–120.

Le Dantec V, Dufrêne E, Saugier B. 2000. Interannual and spatial variation in maximum leaf area index of temperate deciduous stands. *For Ecol Manage.*, 134 (2000) 71–81.

McElrone AJ, Choat B, Gambetta GA, Brodersen CR. 2013. Water uptake and transport in vascular plants. Nat Educ Knowl 4:6 McKenney-Easterling M. 2000. The potential impacts of climate change and variability on forests and forestry in the Mid-Atlantic Region. *Clim Res,* 14:195–206.

Melillo JM, Butler S, Johnson J, Mohan J, Steudler P, Lux H, Burrows E, Bowlers F, Smith R, Scott L, Vario C, Hill T, Burton A,. Zhou YM and Tang J. 2011. Soil warming, carbon-nitrogen interactions, and forest carbon budgets. *PNAS,* 108:9508- 9512.

Nautiyal S, Rajan KS, Shibasaki R. 2005. Interaction of Biodiversity and Economic Welfare - A Case Study from the Himalayas of India. *Journal of Environtl Infmtics* 6: 111-119.

Peng W, Song T, Zeng F, Wang K, Du H, Lu S. 2013. Spatial distribution of surface soil water content under different vegetation types in northwest Guangxi, China. *Environ Earth Sci.,* 69:2699–2708.

Peterjohn WT, Melillo JM, Steudler PA, Newkirk KM, Bowles FP, and Aber JD. 1994. The response of trace gas fluxes and N availability to elevated soil temperatures. *Eco. Appl,* 4:617–625.

Poole DK., Miller PC. 1981. The distribution of plant water stress and vegetation characteristics in southern California chaparral. *Am Midlands Nat.,* 105:32–43.

Prescott C E, Blevins L L, and. Staley C. 2004. Litter decomposition in British Columbia forests: controlling factors and influences of forestry activities. *Jol. of Ecsystms and Mangmnt.*, 5: 44–57.

Rambal S, Ourcival JM, Joffre R, Mouillot F, Nouvellon Y, Reinchstein M, Rocheteau A. 2003. Drought controls over conductance and assimilation of a Mediterranean evergreen ecosystem: scaling from leaf to canopy. *Glob Change Biol.,* 9: 1813–1824.

Rawat N, Nautiyal BP and Nautiyal MC. 2010. Annual nutrients budget for the grazed and ungrazed sites of an alpine expanse in North-West Himalaya, India. *The Envtlist.*, 30: 54–66.

Reichstein M, Falge E, Baldocchi D, Papale D, Valentini R, Aubinet M, Berbigier P, Bernhofer C, Buchmann N, Gilmanov T, Granier A, Grünwald T, Havránková K, Janous D, Knohl A, Laurela T, Lohila A, Loustau D, Matteucci G, Meyers T, Miglietta F, Ourcival JM, Rambal S, Rotenberg E, Sanz M, Seufert G, Vaccari F, Vesala T, Yakir D. 2006. On the separation of net ecosystem exchange into assimilation and ecosystem respiration: review and improved algorithm. *Glob Change Biol.,* 11: 1424-1439.

Reichstein M, Tenhunen JD, Roupsard O, Ourcival JM, Rambal S, Miglietta F, Peressotti A, Pecchiari M, Tirone G, Valentini R. 2002. Severe drought effects on ecosystem CO2 and H2O fluxes at tree Mediterranean evergreen sites: revision of current hypotheses. *Glob Change Biol.,* 8:999–1017.

Rustad LE, Campbell JL, and Marion GM. 2001. A meta-analysis of the response of soil respiration, net nitrogen mineralization, and aboveground plant growth response to experimental ecosystem warming. *Oecologia,* 126:543–562.

Salinger S. 2005. Increasing climate variability and change: reducing the vulnerability. *Clim Change.,* 70:1–3.

Saxe H, Cannell MGR, Johnsen O, Ryan MG, Vourlitis G. 2001. Tree and forest functioning in response to global warming. *New Phytol.*, 149:369–400.

Schafer KVR, Oren R, Lai CT, Katul GG. 2002. Hydrologic balance in an intact temperate forest ecosystem under ambient and elevated atmospheric CO2 concentration. *Glob Chnge Biol.,* 8:895–911.

Schär C, Vidale PL, Lüthi D, Frei C, Häberli C, Mark A, Liniger MA, Appenzeller C. 2004. The role of increasing temperature variability in European summer heatwaves, *Nature,* 427:332–336.

Wilson KB, Hanson PJ, Baldocchi DD. 2000. Factors controlling evaporation and energy partitioning beneath a deciduous forest over an annual cycle. *Agri For Meteorol.,* 102:83–103.

Xu S, Liu LL, Sayer EJ. 2013. Variability of above-ground litter inputs alters soil physicochemical and biological processes: a meta-analysis of litterfall-manipulation experiments. *Biogeosciences,* 10:7423–7433.

Xu Xand Hirata E. 2005.Decomposition patterns of leaf litter of seven common canopy species in a subtropical forest: N and P dynamics. *Plant and Soil*, 273:279–289, 2005.

Yu SY, Jian FG, Guang SC, Jin SX, Li PC and Lin P. 2004. Litterfall, nutrient return, and leaf-litter decomposition in four plantations compared with a natural forest in subtropical China. *Annals of Frst Sci.*, 61:465–476.

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