National Mission on Himalayan Studies (NMHS)

HIMALAYAN RESEARCH FELLOWSHIP

(FORMAT FOR THE HALF YEARLY PROGRESS REPORT)

[Reporting Period: from 01-04-2019 to 30-09-2019]

Name of the Institution/ University:	University of Kashmir
No. of Himalayan Research/Project Associate:	3
No. of Himalayan Junior Research/Project Fellows:	9

Himalayan Research/Associate

H-RAs Profile Description:

S. No.	**Name of RA**	**Date of Joining**	**Name of the PI**	**Qualification**
1.	Dr. Arjumend Shaheen	22-09-2018	Dr. Irfan Rashid Assistant Professor, Department of Botany	M.Sc., Ph.D. in Botany
2.	Dr. Javaid M Dad	18-06-2018	Dr. Irfan Rashid Assistant Professor, Department of Botany	M.Sc., Ph.D. in Environmental Science
3.	Dr. M. Maroof Ahmed	23-06-2018	Dr. Irfan Rashid Assistant Professor, Department of Botany	M.Sc., Ph.D. Biochemistry

Progress Report: To be filled for each HRA in separate row.

RA No.	Research Objectives	Achievements	Addressed Deliverables	Location of Field Site with Details, if any
1.	Assessment of Kashmir Himalayan Biodiversity at Genetic, Species and Ecosystem levels along with Listing Threatened and Endemic Species (Kashmir Himalaya)	• Categorization of endemic Plant species belonging to their respective families was compiled from the available literature and tabulated accordingly **Annexure 1**). • The major families facing the risk of extension were reported as Ranunculaceae, Lamiaceae, Rosaceae, Asteraceae, Primulaceae, Brassicaceae, Boraginaceae and Fabaceae **(Annexure 1**).	(i) A comprehensive Database of Regional Biodiversity. (ii)List of threatened and endemic species with specific uses that require immediate attention. (iii) To categorize the endemic and threatened plants depicting their specific uses, in order to document them in tabulated form that can be of great benefit to the researchers as well as the students working on such plant species in near future.	**(Please see Annexure 1)**
2.	• Assessment of the most pervasive changes in terms of Climate Change (CC), Invasive Species, Degradation of Land and Water Resources	During the preceding time period, I have collected the annual precipitation and temperature data from six regional stations of Indian Meteorological Department. The data collected pertains to the time period of 1980-2016. The detailed analysis of this data set, is attached as separate file. In relation to documenting the invasive species distribution over a specified time period, we have zeroed on studying the distribution of *Sambucus wightiana.* To this end, the documented distribution of above listed species	A document on Climate Change (CC)-induced variations and trends observed in the Kashmir Himalaya along with preventive measures**. **As until now we have collected data that pertains to the time period of 1980-2016, we aim to increase its periodicity so that the end product document which will show the variations and trends in the Kashmir Himalaya would be an inclusive one. Based on that data set, we will frame preventive measures.	**(Please see Annexure 2)**

		through secondary literature will be first subjected to ground truth and then its futuristic distribution scenario will be analyzed.		
3.	• Screening and listing of species guided by traditional uses and biologically relevant metabolites with therapeutic potential • Potential Drug Leads	• Extracted secondary metabolites from two important traditionally used medicinal plants through liquid extraction using Soxhlet. • Analysis of the crude extracts so obtained was done through thin layer chromatography which will be followed by column chromatography in order to purify the lead molecules. DPPH radical scavenging activity of the crude extracts was determined with reference to α-tocopherol taken as known free radical scavenger (positive control).	• Different crude extracts were obtained through Soxhlet extraction method using different solvents with respect to polarities viz. Hexane, Ethyl acetate, Ethanol, Methanol and Water. • Separation of different categories of secondary metabolites from the crude extracts was achieved through chromatographic techniques viz. TLC and column chromatography. • Various concentrations of the crude extracts (100-700 µg/ml) were used in DPPH (1,1-diphenyl-2-picrylhydrazyl) assay. • Percentage inhibition of crude extracts was calculated by using the formula: % inhibition = $[(A_C-A_S)/A_C]$ X 100. • Results of the radical	• Field site i.e. Ladakh Himalaya (Leh and Kargil) is the northern most part of India with an average altitude of 3505 m above sea level with a latitude of 31°44`57``-32°59’57``N and longitude of 76°46`29``-8°41`34``E and is one of the most elevated regions of the world. • Kargil and Leh comprises of several river-side valleys and mountain-side settlements out of which the five major valleys include: Indus, Nubra, Changthang, Zanskar and Suru valley. **(Please see Annexure 3)**

			scavenging activity of the crude extracts were represented by calculating the IC_{50} values (Annexure-I) • Most potent extract with maximum antioxidant activity was found to be the ethyl acetate extract with least IC_{50} value (107.9 µg/ml) comparable with that of the α-tocopherol taken as positive control with IC_{50} value of (24.19 µg/ml) • Thus ethyl acetate extract exhibits the maximum free radical scavenging activity followed by methanol, ethanol and water extracts. Least activity was exhibited by hexane extract with an IC_{50} value of (217 µg/ml).	

Note: Data, table and figures may be attached as separate source file (.docx, .xls, jpg, .jpeg, .png, .shp, etc.)

Himalayan Junior Research/Project Fellows

H-JRFs Profile Description:

S. No.	Name of JRF	Date of Joining	Name of the PI	Qualification
1.	Summia Rehman	16-02-2017	Dr. Irfan Rashid	MSc. Botany; NET
2	Aqleemul Islam	19-06- 2018	Dr. Irfan Rashid	MSc. Zoology
3.	Ishfaq Ul Rehman	24-09-2018	Dr. Irfan Rashid	MSc. Botany; NET
4.	Mohamad Junaid	11-02-2017	Dr. Irfan Rashid	MSc. Geo-Informatics
5.	Saleem Farooq Rather	22-09-2018	Dr. Irfan Rashid	MSc. Environmental Science; NET
6.	Mohammad Yaseen Mir	08-02-2017	Dr. Irfan Rashid	MSc., MPhil. Botany
7.	Shabana Khurshid	10-02-2017	Dr. Irfan Rashid	MA., MPhil. Social Work; NET
8.	Gazalla Akhtar	24-09- 2018	Dr. Irfan Rashid	MSc. Food Technology; NET
9.	Nafiya Qadir	24-09-2018	Dr. Irfan Rashid	MSc. Food Technology; NET

Progress Report: To be filled for each JRF in separate row.

JRF No.	Research Objectives	Achievements	Addressed Deliverable	Location of Demonstration/ Study Site with Details
1.	Conservation of genetic resources of rare, endemic, threatened (RET) species.	An attempt has been made to describe 249 endemic species in Kashmir Himalaya. Of these 249 endemic plant species, threat status of 56 species has been accessed and for 19 species conservation has been done by using different conservation techniques. Presently *Phlomis cashmeriana* has been conserved using seeds as explant.	A comprehensive Biodiversity Database developed and utilized in decision-making (conservation practices).	Kashmir Himalaya, due to its geo-strategic position and ideal climate, Kashmir Himalayan possesses a rich biodiversity. The region lies between 32^o 20' to 34^o 50' North latitude and 73^o 55' to 75^o 35' East longitude covering an area of about 15,948km^2 with nearly 64% of mountainous area. **(Please see Annexure 4)**
2.	Assessment of level of reduction/ increase in human-wildlife conflicts in Kashmir Himalayas.	The present research work was carried out in central division of Kashmir valley to know the present status of human wildlife conflict in Kashmir Himalayas Survey of Central Kashmir (district: Srinagar)	A brief report on Preventive Measures on Human-Wildlife conflicts and landscape-level best practices.	**(Please see Annexure 5)**
3.	Effectiveness of approaches developed for reduction of IAS.	Performance of three assessment schemes in predicting invasive plant species in Kashmir Himalaya has been tested.	A manual on landscapes restoration practices by restricting proliferation of invasive alien species in the kashmir Himalaya.	In Kashmir Himalaya, the site i opted is Sinthen top. It is located between South Kashmiris Breng Valley and Kishtwar. Its elevation is 3,748m with coordinates of 33^O 34' 53 N and 75^o 30' 39 S. **(Please see Annexure 6)**

4.	Number of watersheds studied/Plans prepared and executed.	Watershed prioritization using Morphometric parameters (Linear & Shape parameters).	Periodic utilization of ground water and Aquifers and their recharge to ensure sustainability.	**(Please see Annexure 7)**
5.	No. of spring-sheds investigated and treated/rejuvenated.	• Issues responsible for drying up of springs • Management/rejuvenation • Microbial load in spring waters	Development of a database on utilization and recharge of ground water and Aquifers Some of the major issues responsible for drying up of springs have been identified. Measures that can be taken up for the management of existing springs and rejuvenation of dried ones. Water samples were collected from different springs to check the presence of pathogenic bacteria in spring water.	**Geographic coordinates** 32°33’07” & 33° 07’30” N 74°27’00” & 77°21’00” E **(Please see Annexure 8)**
6.	Significance of multipurpose tree species in degraded land rehabilitation	• The satellite mapping and field observations of Kargil region revealed that the larger area of this region was found barren land (44.03 %) followed by vegetation i.e. 38.59 %. The vegetation cover shows distinct strata with moist alpine pastures covering an area of 30.02 %, followed by moist alpine scrub	Multi-purpose trees and other flora for different agro-climatic zones identified.	Ladakh Himalaya covers more than 70,000 sq km geographical area of Jammu & Kashmir state, lies between 31°44`57``-32°59’57``N latitude and 76°46`29``-8°41`34``E longitude.

		covering 7.43 %, agroforests 1.1 % and subalpine forests 0.04 % (Fig 1). • The subalpine forests were found in the altitude range of 3000 m - 4000 m and were dominated mainly by *Pinus wallichiana* and *Juniperus semiglobosa* • Agroforests comprises clusters of *Populus* and *Salix* species in the areas near rivers and streams. These species were mostly planted adjacent to agricultural fields by local people and forest department. The agroforests were found in the altitude range of 2500 m - 3600 m. The contour map of Kargil region is shown in Fig 1. • Alpine scrubs were found in the altitude range of 2800 m -5100 m and were dominated mainly by *Hippophae rhamnoides* and *Myricaria germanica.* • The alpine pastures were mainly moist alpine grasslands occurring at higher altitudes around 5800 m near the snow line. These regions were dominated by *Ephedra gerardiana* and *Poa alpine.* • The multifunctional trees observed during the field survey included *Salix alba*, *S. elegans*, *S. tetrasperma*, *S. hastate*, *S. fragilis*, S. *sclerophylla*, *S. fragilis*, *S. daphonoids*, *Populus alba*, *P. euphratica*, *P. nigra*, *P. ciliate*, *P. angustifolia*, *P.*		The sites selected include Kargil city, Trespone, Saliskote, Sankoo, Suru, Panikhar, Batalik, Fokar, Mulbek, Lamayuru, Saspol, Leh city etc. These sites were selected on the basis of good human population and being ecologically important when compared with the objective of our study. **(Please see Annexure 9)**

		balsamifera, *Juniperus macropoda*, *J. communis*, *Ephedra vulgaris* and *Hippophae rhamnoides.* • The important multifunctional trees and shrubs were planted in different barren habitats in order to evaluate the ecological suitability of these plants and their role in rehabilitation of degraded lands.		
7.	Level and diversity of engagement of traditional institutions in environment protection.	Insight of the possible challenges and threats to the fragile environment of ladakh.	Their roles, norms and practices for sustainable resource management, environment protection and socio-economic development.	**(Please see Annexure 10)**
8.	Gazalla Akhtar			**Resigned**
9.	To enhance knowledge about indigenous foods prepared in Kargil for combating extreme cold.	Knowledge about processed foods being prepared in the region was gained through information obtained by interviewing the inherent knowledgeable people of Kargil. These foods were put into 3 separate sections on the basis of food resource used as base material for preparation into cereal products, dairy products and beverages.	The inhabitants of Kargil region of Ladakh have developed several indigenous food products and beverages based on organic produce that is produced in the region for coping up with extremity of environment. From past analysis, it was revealed that methods of farming practiced by the farmers of the region were purely organic in nature.	Kargil, a part of Ladakh Himalayas is situated on the northern side of India situated 2,676 m above sea level. **(Please see Annexure 11)**

			Therefore, people of Kargil prepare diverse ethnic food products from barley, wheat, apricot, milk etc by making use of sustainable processing techniques. After conducting survey of the region, it was revealed that the local food products such as *Derba*, *Kaptsey*, *Kholak*, *Tagi Khambir* etc are prepared by the use of traditional processing methods. Besides these, the natives of Kargil also prepare salted tea beverages such as *Gurghur cha* and *Kunak* for refreshing themselves. Kargil region of Ladakh is well known for good quality apricots. Apart from the consumption of fresh and dried apricots, some portion is utilized for preparation of apricot beverage locally called *Chulli chu* that besides having a good nutritive profile is well known for its thirst quenching	

			nature.	

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Annexure 1

HRA-1 (Dr Arjumend Shaheen)

The major plant families facing the risk of endemism and their respective species

Family	Plant name
Ranunculaceae	*Aconitum chasmanthum* Stapf ex Holmes *Aconitum heterophyllum* Wall. ex Royle var. Bracteatum Stapf *Aquilegia nivalis* Falc. ex Baker *Delphinium cashmerianum* Edgew *Paraquilegia microphylla* (Royle) J.R. Drumm. & Hutch *Ranunculus palmatifidus* H. Riedl *Ranunculus stewartii* H. Riedl
Lamiaceae	*Ajuga bracteosa* Wall. ex. Benth. *Chelonopsis cashmerica* (Mukerjee) Hedge *Nepeta campestris* Benth *Nepeta eriostachys* Benth *Phlomis bracteosa* Royle ex Benth. *Phlomis cashmeriana* Royle
Alliaceae	*Allium Kachroori* G. Singh
Rosaceae	*Alchemilla kashmiriana* Rothmaler *Cotoneaster microphyllus* Wall. ex. Lindl. *Crataegus clarkei* Hook. f. *Potentilla breviscissa* Bertol *Potentilla clarkei* Hook. f. *Potentilla doubjouniana* Cambess *Potentilla kashmirica* Hook. f. *Rubus antnnifer* Hook.f. *Sorbaria aitchisonnii* (Hemsl.) Rehder *Sorbus cashmiriana* Hedlund *Spiraea affinis* Parker *Spiraea emarginata* Purohit & Panigrahi
Asteraceae	*Allardia stoliczkai* C. B. Clarke *Anaphalis royleana* DC *Artemisia amygdalina* Decne *Artmisia banihalensis* Kaul & Bakshi *Artemisia cashmerica* Kaul & Bakshi *Bidens minima* Huds *Bidens tetraspinosa* Kak and Javeid *Chondrilla graminea* var kashmiriana *Chondrilla pauciflora* Ledeb *Chondrilla maniforma* *Chondrilla setulosa* Clarek *Chrysanthemum tibeticum* HK.f. &T *Cicerbita lessertiana* (Wall. ex. DC.) Marngain &Rao ssp. Dentate (DC.) Mamgain & Rao

	Circium wallichii (DC.) Pletlepi *Cousenia falconeri* HK.f. *Cremanthodium ellisii* Kitam *Crepis dachhigamensis* Gurcharan Singh *Crepis kashmirica* Babe *Crepis Pulchra* L. *Dolomiaea baltalensis* Dar & Naqshi Doronicum falconeri Clarke ex Hook. f. *Erigeron jaeschkei* Vierh *Eigeron roylei* DC. *Eigeron semibarbata* (DC) HK.f. *Gerbera lacei* Watt *Inula clarkei* (H.k.f) R. R Stewart *Inula racemosa* Hook. f. *Inula rhizocephala* Schrenk *Inula royleana* Clarke *Jurinea ceratocarpa* (Decne.) Benth. *Jurinella macrocephala* var. tibetica *Jurinella* rosulata Klatt. *Lactuca kashmiriana* Mamgain & R.R. Rao *Lactuca lessertiana* Clarke var. lyrata *Lactuca tatarica* (L) Mey. *Lactuca benthamii* Clarke *Leontopodium conocephalum* Edgrew. *Saussurea andryaloides* (DC.) Sch.- Bip.- *Saussurea atkinson.* Clarke *Saussurea clarkei* Hook.f. *Saussurea costus* (Falc.) Lipsch *Saussurea ceratocarpa* Decne *Saussurea clarkei* H.f. *Scorzonera alba* R. R. Stewart *Senecio jacquemontianus* (Deene.) Benth. Ex Hook.f. *Senecio laetus var. analogus* (DC) R. Mathur ex Karthik & Moorthy. *Tanacetum Gracile* Hook. f. &Thomson *Tragopogon kashmirianus* Singh *Taraxacum amblylepidocarpum* V. Soest *Taraxacum coronatum* Hand *Taraxacum elegans* V. Soest *Taraxacum flavum* V. Soest *Taraxacum fulvescens* V. Soest *Taraxacum gulmaragense* V. Soest *Taraxacum helianthemum* V. Soest *Taraxacum hoftii* V. Soest *Taraxacum kashmiriense* V. Soest *Taraxacum nigrum* V. Soest *Taraxacum nivale* V. Soest *Taraxacum pseudosteven* V. Soest *Taraxacum stewartii* (Spreng) V. Soest *Taraxacum xanthophyllum* Haglund

Primulaceae	*Androsace duthieana* Rothmaler *Androsace mucronifolia* Watt *Androsace muscoidea* Duby *Cortusa matthioli* Linn. Ssp. Hazarica Y. Nasir *Primula clarkei* Watt. *Primula duthieanq* Balf. f. & W. W. Smith *Primula hazarica* Duthie
Apiaceae	*Angelica glauca* Edgew *Bupleurum clarkeanum* (Wolff) E. Nasir *Bupleurum longicaule* Wall. ex. DC. Var. ramosum E. Nasir *Chaerophyllum cashemiricum* Clarke var. dissecta Clarke *Heracleum candicans* Wall. ex DC *Ligusticum thomsonii* Clarke Var evolutior Clarke *Pleurospermum brunonis* (DC.) Clarke f. latisectum Schulz
Brassicaceae	*Arabidopsis sarbalica* Naqshi & Javeid *Arabis kashmerica* Naqshi & Javeid *Arabis tenuirostris* O. Schulz *Christolea scaposa* Jam *Christolea stewartii* (T. Anders.) Jafii *Draba aubrietoides* Jafii *Draba lasiophylla* Royle var. nubigena (Schulz) Naqshi & Ara *Drabopsis brevisliqua* Naqshi & Javeid *Ermania kachroori* Dar & Naqshi Ermania kashmiriana Dar & Naqshi *Erysimum cachemiricum* O. E. Schulz *Lepidium virginicum* Linn. Var. kashmiricum Dar & Naqshi *Lignariella duthiei* Naqshi *Megacarpaea bifida* Benth *Megacarpaea polyandra* Benth *Microsisymbrium flaccidum* O. E. Schulz *Thalspi cornuticarpum* Naqshi
Boraginaceae	*Arnebia benthamii* (Wall ex. G. Don.) I. M. Johnst. *Onosma hispida* Wall. ex. G. Don *Pseudomertensia drummondii* kazmi *Pseudomertensia elongate* (Decne.) Riedl *Pseudomertensia moltldodes* (Royle ex benth.) Kazmi *Pseudomertensia trollii* (Melch.) Stewart & Kazmi var. trollii
Fabaceae	*Astragalus bakeri* Ali *Astragulus candolleanus* Royle ex Benth *Astragulus concretus* Benth *Astragulus kashmirensis* Bunge *Astragulus maxwelii* Royle ex Benth Lespedeza elegans Cambess *Trigonella podperae* (Sirj.). Vass.

HRA-2 (Dr. Javaid M Dad)

Summary of research work done:

Annual temperature and precipitation data from six stations of Kashmir valley, India during the last three decades, from 1980 to 2017, were analyzed to determine spatial and temporal trends. Analysis of mean annual maximum and minimum temperature and precipitation demonstrates high inter and intra-station variability owing to altitudinal variation and spatial distribution of IMD stations across the region (Table 1).

Table1. Summarized temperature and precipitation results for time series (1980-2017) showing variability across IMD stations for Kashmir valley, India.

Station	Location	Alt. (m a.s.l.)	T_{Max} (°C)		T_{Min} (°C)		Precipitation (mm)	
			Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD
Srinagar	34° 05′ 74° 50′	1588	17.1-21.8	19.7±1.0	6.5- 8.4	7.5±0.4	337.3-1160.3	711.6±181.6
Gulmarg	34° 03′ 74° 24′	2705	9.9- 13.8	11.7±0.9	0.3-4.3	2.5±1.0	499.4-2382.3	1422.2±433.4
Kokernag	33° 40 ′ 75° 17′	1910	15.7-20.3	18.1±1.1	4.6-7.7	6.4±0.6	568.6-1587.2	1041.8±336.7
Kupwara	34° 25 ′ 74° 18′	1609	17.8-22.2	20.2±1.0	5.0-7.3	6.4±0.5	271.3-1600.4	724.4±264.3
Pahalgam	34° 02′ 75° 20′	2310	14.3- 18.4	16.6±0.9	1.8-4.3	3.0±0.6	892.2-1651.9	1281.7±232.3
Qazigund	33° 35′ 75° 05′	1690	17.6-20.9	19.3±0.7	5.6-7.1	6.4±0.4	370.4-1693.3	852.3±330.3
Kashmir valley			15.7-19.4	17.6±0.8	4.4-6.5	5.4±0.4	697.6-1528.4	1005.5±197.6

Our analysis if precipitation data revealed that climate of Northwest Kashmir Himalayas is mainly governed by mid-latitude westerlies (Western disturbances) and Indian summer monsoon (ISM) adding variability to regional climate. Time series of meteorological data from (1980-2017), reveal that Kashmir region receives nearly three-quarters precipitation (71.54%) from October to May, contributed by western disturbances. The remaining, 28.46% of rainfall occurs from June to September during southwest monsoons (ISM). The influence of mid-latitude westerlies is greatest on IMD stations towards north of the valley (Gulmarg and Kupwara) while as, it is least on IMD stations towards south of valley (Kokernag). The detailed results for Kashmir valley are summarized in **Fig 1.**

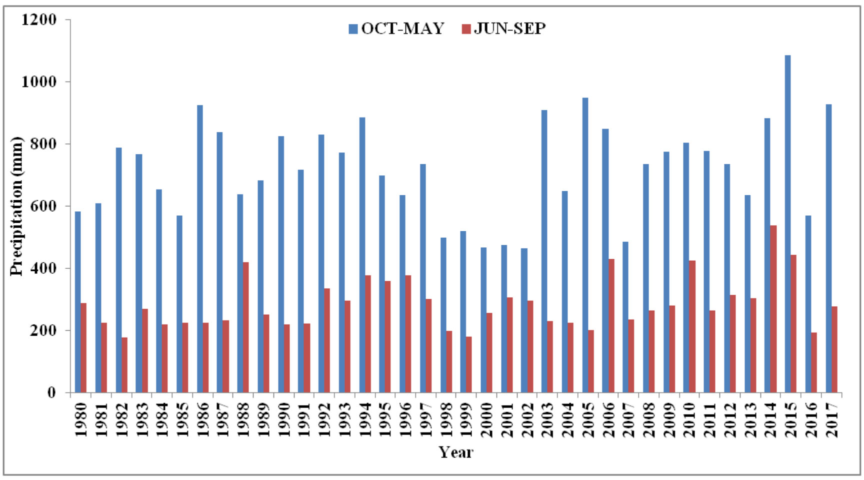

Fig.1 Long-term annual precipitation for time series 1980-2017, from Kashmir valley received during the period of westerlies (October to May), and southwest monsoons (June to September).

To detect change in climatic parameters, estimate and predict trends and their physical significance is important aspects of climate research. In present study time series (1980-2017) of meteorological data was analyzed using Mann-Kendall (M-K) test for six IMD stations across Kashmir valley. The M-K test was combined with Theil-Sen robust estimate of linear trend showed that mean annual maximum and minimum temperature for time series (1980-2017) for lower altitude stations experience usually higher temperatures, show relatively higher variability while high altitude stations with lower temperature show least variability. For Kashmir valley as whole, the results indicated that mean annual maximum and minimum temperatures, show statistically significant ($p<0.05$) positive annual trends while for individual stations, noticeable variations were evident (Fig 2).The IMD stations of Kokernag, Kupwara and Pahalgam exhibited a significant ($p<0.01$) positive trend for both minimum and maximum annual temperature. Gulmarg and Qazigund station did not recorded any trend. However, irrespective of statistical significance of observed time series of meteorological data across IMD stations, a clear characterization in positive trend is evident from both mean annual maximum and minimum plots (Fig 2).

Precipitation pattern over entire region showed a strong variability with trend being mostly non-significant (Table 4). For whole Kashmir valley, the results indicated non-significant ($p>0.05$) positive increase in precipitation for observed time series (Fig 3). Among all stations, Kupwara and Qazigund stood different and recorded significantly ($p<0.01$) positive trend for precipitation while other stations recorded a statistically non-significant ($p>0.05$) trend with an annual decrease.

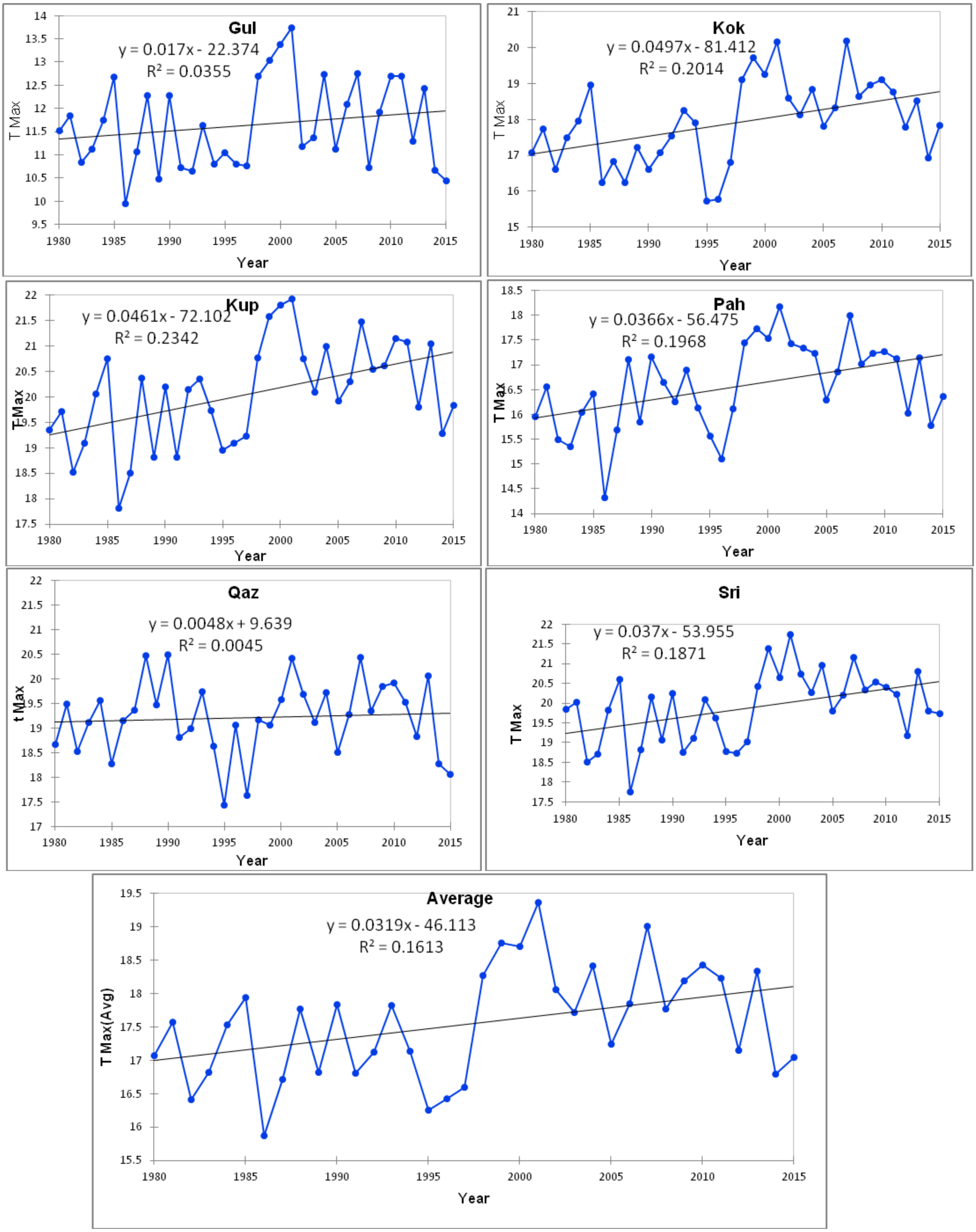

Fig 2. Variations in maximum annual temperature observed across six stations across Kashmir valley between 1980-2017. The average represents Kashmir valley. Abbreviations used include: Kok= Kokernag, Sri= Srinagar, Gul=Gulmarg, Pah=Pahalgam, Kup=Kupwara, Qaz=Qazigund.

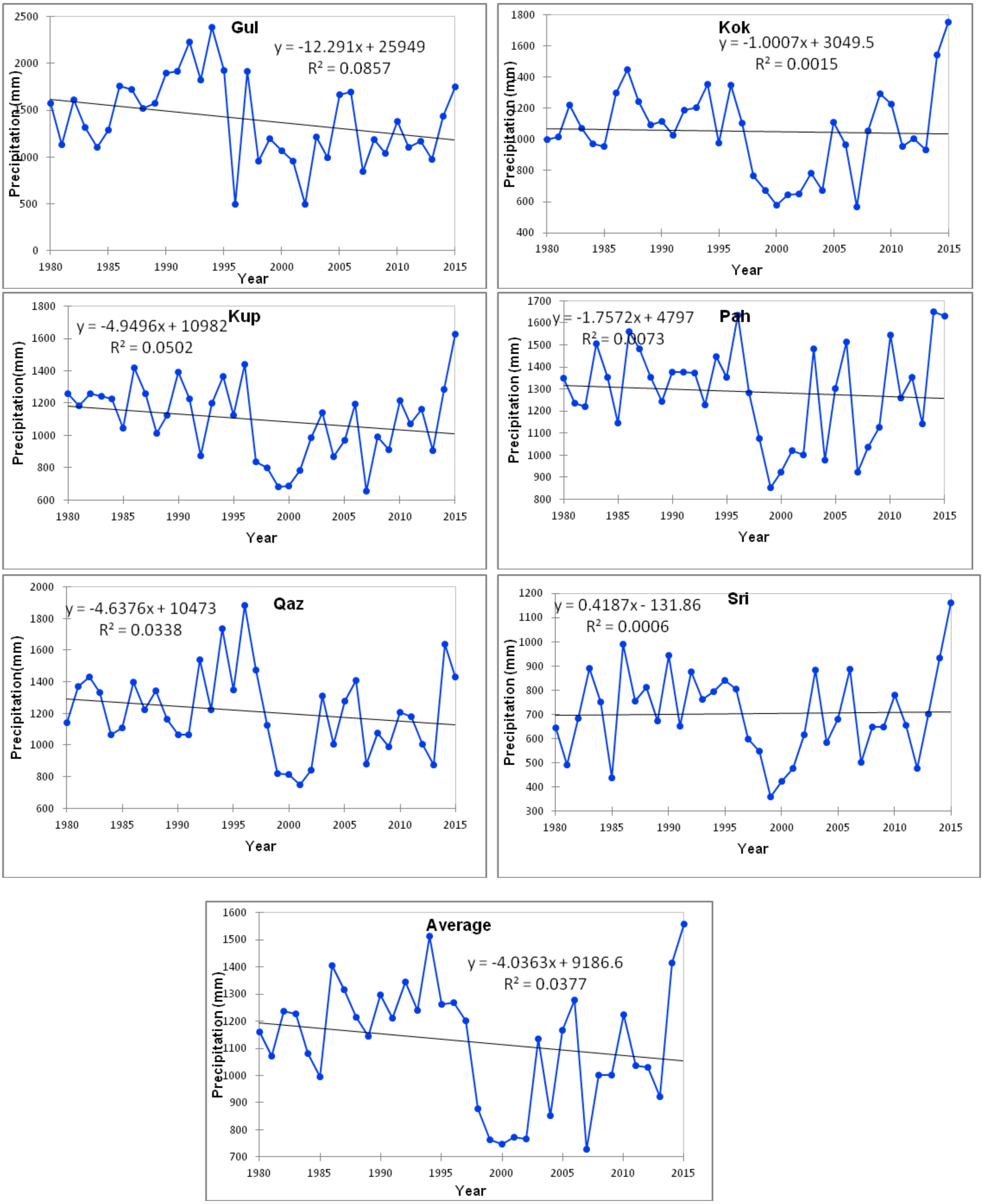

Fig 3. Variations in annual precipitation observed across six stations across Kashmir valley between 1980-2017. The average represents Kashmir valley.

Summary of research work done from June, 2019 to October, 2019.

Annual temperature and precipitation data from six stations of Kashmir valley, India during the last three decades, from 1980 to 2017, were analyzed to determine spatial and temporal trends. Analysis of mean annual maximum and minimum temperature and precipitation demonstrates high inter and intra-station variability owing to altitudinal variation and spatial distribution of IMD stations across the region (Table 1).

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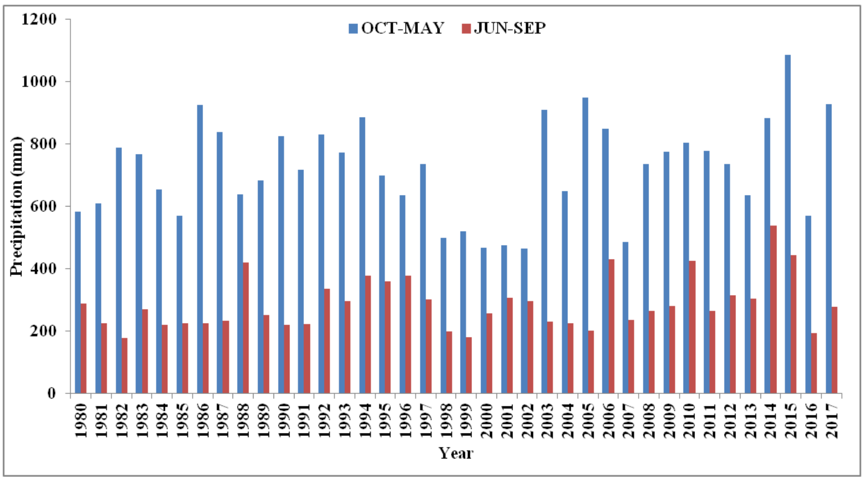


Fig.1 Long-term annual precipitation for time series 1980-2017, from Kashmir valley received during the period of westerlies (October to May), and southwest monsoons (June to September).

To detect change in climatic parameters, estimate and predict trends and their physical significance is important aspects of climate research. In present study time series (1980-2017) of meteorological data was analyzed using Mann-Kendall (M-K) test for six IMD stations across Kashmir valley. The M-K test was combined with Theil-Sen robust estimate of linear trend showed that mean annual maximum and minimum temperature for time series (1980-2017) for lower altitude stations experience usually higher temperatures, show relatively higher variability while high altitude stations with lower temperature show least variability. For Kashmir valley as whole, the results indicated that mean annual maximum and minimum temperatures, show statistically significant ($p<0.05$) positive annual trends while for individual stations, noticeable variations were evident (Fig 2).The IMD stations of Kokernag, Kupwara and Pahalgam exhibited a significant ($p<0.01$) positive trend for both minimum and maximum annual temperature. Gulmarg and Qazigund station did not recorded any trend. However, irrespective of statistical significance of observed time series of meteorological data across IMD stations, a clear characterization in positive trend is evident from both mean annual maximum and minimum plots (Fig 2).

Precipitation pattern over entire region showed a strong variability with trend being mostly non-significant (Table 4). For whole Kashmir valley, the results indicated non-significant ($p>0.05$) positive increase in precipitation for observed time series (Fig 3). Among all stations, Kupwara and Qazigund stood different and recorded significantly ($p<0.01$) positive trend for precipitation while other stations recorded a statistically non-significant ($p>0.05$) trend with an annual decrease.

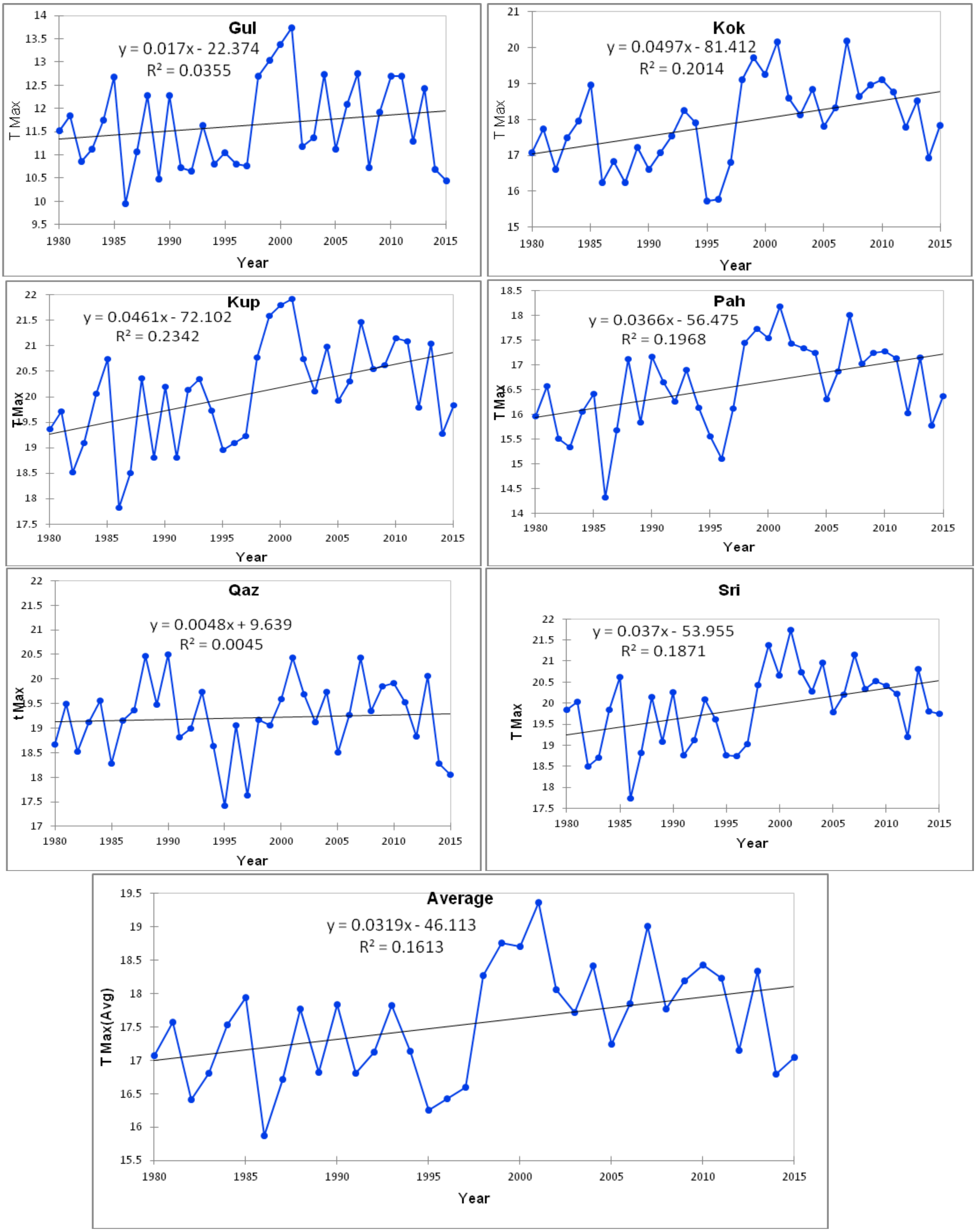


Fig 2. Variations in maximum annual temperature observed across six stations across Kashmir valley between 1980-2017. The average represents Kashmir valley. Abbreviations used include: Kok= Kokernag, Sri= Srinagar, Gul=Gulmarg, Pah=Pahalgam, Kup=Kupwara, Qaz=Qazigund.

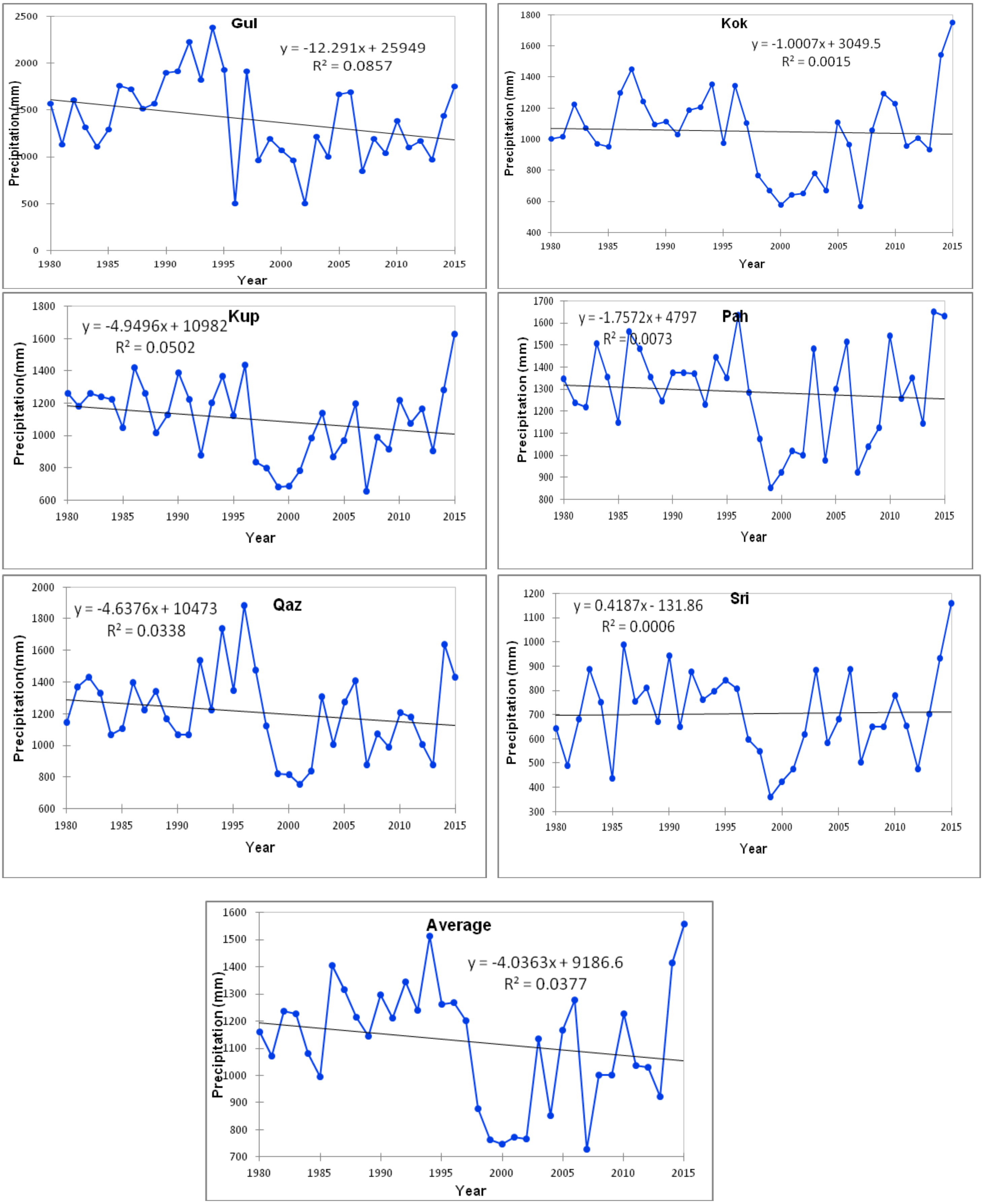


Fig 3. Variations in annual precipitation observed across six stations across Kashmir valley between 1980-2017. The average represents Kashmir valley.

Annexure-3

Table 1: DPPH radical scavenging activity of different crude extracts from *Hippophae rhamnoides* (Seabuckthorn) with respect to their percentage inhibitions and IC_{50} values

S. No.	Plant Extract	Percentage inhibition at different concentrations							IC_{50} values (µg/ml)
		100 µg/ml	**200** µg/ml	**300** µg/ml	**400** µg/ml	**500** µg/ml	**600** µg/ml	**700** µg/ml	
01	**Hexane extract**	42.836	50.361	54.124	58.610	62.662	64.833	67.366	217.0
02	**Ethyl acetate extract**	43.837	55.146	67.280	80.304	81.512	87.102	87.484	**107.9**
03	**Ethanol extract**	49.102	52.757	57.408	67.242	72.425	76.013	80.996	130.4
04	**Methanol extract**	47.264	55.266	59.439	65.389	69.835	72.913	78.043	115.5
05	**Water extract**	44.877	52.015	59.550	68.473	74.157	78.982	80.634	152.7
06	**PC***	30.781	43.287	60.095	69.219	83.562	93.660	96.947	**24.19**

*(PC) positive control (Alpha-tocopherol)

Annexure-4

H-JRF-1 (Sumaiya Rehman)

Results

Kashmir Himalaya, considered one of the greatest treasures of biodiversity, harbors a rich diversity of endemic plant species. The endemic plant taxa are generally prone to threat because they are rare and show ecosystem or habitat specialization. Number of plant species found here is rapidly disappearing due to which this endemic wealth of plant species is highly susceptible to extinction. This calls for immediate conservation measures for endemic plants in general and rehabilitation of the endangered ones in particular. Consequently, under such circumstances it has become eminent to conserve the biodiversity of Kashmir Himalaya, as our lives hugely depend on it. The Biodiversity of Kashmir Himalaya is threatened by a variety of global changes resulting from the combined action of human society. The most direct threats are overharvesting and loss/disturbance of habitat resulting from conversion of natural ecosystem to human use. A perusal of literature indicates that studies pertaining to the diversity, nativity, endemism, rarity, review of in-situ & ex-situ conservation programs, and problems related to cultivation of threatened plants for conservation and strategy action plan had not been carried out so far.

An attempt has been made to describe 249 endemic species in Kashmir Himalaya belonging to 122 genera in 40 families. Of these, 227 species belong to dicotyledons in 108 genera and 34 families, while as 22 species are monocotyledons in 14 genera and 6 families. The threat status of these species has been given according to IUCN regional guidelines. The species are prioritized for conservation based on RET status. Of the 249 endemic plant species, till date, threat status of only 56 species has been accessed.

Conservation of *Phlomis cashmeriana* has been achieved using seeds as explants.

- *Phlomis cashmeriana* is endemic to Kashmir Himalaya and Pakistan.
- Work on reproductive biology and other aspects has revealed that general threats to these taxa include restricted and specialized habitats, poor fruit and seed-setting, low dispersal rate, poor pollen/seed viability, commercial exploitation, and grazing and predation.
- Seed biology experiments depicted that the seeds have tough seed coat which acts as a barrier for germination and resulted in low population size.
- Different conservation techniques have been applied to prevent extinction of this valuable plant species and to improve conservation status.
- Presently tissue culturing using seeds as explant has been used to conserve this plant species.

Phlomis cashmeriana, a rear medicinal plant growing in the alpines regions of Kashmir Himalaya can be rescued from extinction by subjecting its various explants to *in vitro* propagation.

MS medium with varying levels of Kinetin (2.5, 5, 10, 15 μM) in combination with different levels of NAA (0.5, 5, 10, 15 μM) were used. MS medium with Kinetin (0.5mg/L) and NAA(1mg/L) formation proved effective for callus formation.

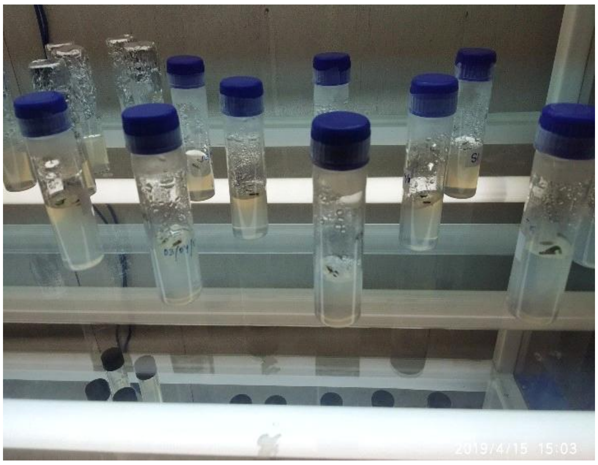


Fig 1: Experiments/Observations.

Annexure-5

H-JRF-2 (Aqleemul Islam)

Study Area

The study area of the research work comprises the whole Kashmir valley, also known as Vale of Kashmir, Peer waer, Resh waer. The Kashmir division is one of the three administrative divisions of the Indian state of Jammu and Kashmir. The Kashmir division borders Jammu division to the South and Ladakh to the east while Line of Control forms its Northern and Western border. The area of the Kashmir comprise of 15,948 km^2 (6,158sq mi) and an elevation of 1,620 m(5,314ft). The climate of kashmir is of moderate type. The valley is surrounded on all sides by great mountain ranges, with Pir - Panjal range on the Southwest and Main Himalayan range on the Northeast. These mountains are covered by dense vegetation and forest cover which enriches the biodiversity here.

As human population increases the demands of natural resources also increases, and human habitation expands near the boundaries of these mountains as a result of this the humans and wildlife sometimes accidently come in contact with each other creating negative impacts on each other. Kashmir valley is further divided into three divisions i.e,

-South (District :Anantnag, Kulgam, Shopian, Pulwama)

-Central (District: Srinagar, Budgam, Ganderbal)

-North(District: Baramulla, Bandipora, Kupwara).

The present study was carried out in central division of Kashmir valley to know the issue of human-wildlife conflict in attack prone areas of central Kashmir.

Data from wildlife department (central division)

- Data of almost ten years was collected and it shows that total of 244 cases of humans were reported and out of this 232 were injury cases and 12 were mortality cases. Table:
- The findings shows that human wildlife conflict is on constant rise in kashmir Himalayas and The animals that were found to be involved in conflict are Black Bear, Leopard, Monkeys, Wolf etc. The Black Bear ranks top amongst them followed by Leopard. Least damage was observed by the rest wild animals.
- House hold surveys for primary collection of data in some areas of south division are presently in process.

Year	**Human mortality/injuries**		**Total no. of cases per year**
	Mortality	**Injured**	
2010-11	03	43	46
2011-12	05	59	64
2012-13	01	29	30
2013-14	02	58	60
2014-15	01	17	18
2015-16	-	12	12
2016-17		14	14
Total	12	232	244

Table 1: Secondary data from wildlife department of central division:

Annexure-6

H-JRF-3 (Ishfaq-ul-Rehman)

The present study revealed that in the Indian Himalayan region a large number of alien species have been reported by various authors from different parts of Kashmir Himalayan region. The present inventorization revealed that the alien flora of Kashmir Himalaya is comprised of 571 plant species belonging to 352 genera and 104 families. Dicotyledonos contribute maximum numer (425) of alien plant species distributed in 261 genera and 74 families, where monocotyledons share 133 plant species grouped under 81 genera and 23 families. Gymnosperms are represented by 11 plant species belonging to 8 genera and 5 families, which include

Cupresseaceae, Ginkogaceae, Pinnaceaea, Taxaceae and Taxodiaceae. Pteridophytes comprise of 2 monotypic families, Marsiliaceae and Salvinaceae.

Three risk assessment schemes (Pheloung et al. (1999), Daehler et al. (2004), Tucker and Richardson (1995) with certain modifications has been successfully performed for Kashmir Himalayas. Among the performed three risk assessment schemes, The Tucker–Richardson decision tree model developed for South African fynbos was least successful in the Kashmir Himalaya, with 6.49% accuracy. This model was designed for application to very specific conditions – fire-prone, nutrient poor shrub lands – that do not occur in the Kashmir Himalaya, and this highlights the need for selection of a risk assessment system that is appropriate for a given region, country or taxa. The average WRA score for Kashmir Himalaya was much greater than that found by some other studies. Based on WRA scoring, individual species were classified as either 'very high risk' (≥18 points), 'high risk' (12–17 points) or 'intermediate risk' (6–11 points).

Of the total of 77 invasive species investigated in the present study, only three (*Sambucus wightiana*, *Iris ensata* and *Juncus articulatus*) qualified as high-risk species, while the other species were very high-risk. Typha angustifolia was given the highest WRA score (32), followed by *Anthemis cotula* and *Conyza canadensis* (each 31).

Risk assessment scheme tested	Invasive species rejected (Ir)	Invasive species accepted (Ia)	Total number of invasive species assessed (It)	Accuracy (%)
Pheloung et al. (1999)	77	0	77	100
Daehler et al. (2004)	77	0	77	100
Tucker and Richardson (1995)	5	72	77	6.49

Using wet sieving and decanting method, AMF spores obtained revealed that spore diversity was more in soils of invaded site as compared to non-invaded site. These spores were mostly from fungal divisions of Ascomycotina and Basidomycotina.

S.NO	INVASIVE PLANT	No of spores/ 30g of soil	
		Invaded site	Non-invaded site (Control)
1	Conyza canadensis	24	4
2	Lucanthemum vulgare	14	2

Annexure-7

H-JRF-4 (Mohamad Junaid)

Watershed management plays a significant role in the conservation of water and soil resources. Therefore, a need for water resources planning, conservation and better management for its sustainable use is required for sustained growth for a country. In India, the approach of watershed management is considered a principal strategy for comprehensive development of water resources primarily in the arid and semi-arid areas of the country. Existing policies of the government of India give more emphasis on strengthening such projects (Wani et al. 2008). The first-phase of watershed development and management from (1969 - 1974) focussed on the soil conservation and its management, while in the second phase from (1974 - 1979) emphasis was given on water conservation, further in the 3rd phase (mid-1990s) programme emphasis has been given on participatory approach for management and development of watershed activities. The watershed management concept recognizes the interrelationships among the linkages between uplands, low lands, land use, geomorphology, slope and soil (Mishra and Nagarajan 2010) and therefore adoption of better watershed management practices overcomes issues of drought, flood, excessive runoff, poor infiltration, soil erosion, human health, and low production yield. However, while considering watershed conservation work, it is not viable to take the whole area at once. Thus, the whole basin is divided into several smaller units, as sub-watersheds or micro-watersheds, by considering its drainage system.

To prepare a watershed development plan, morphometric analysis of the drainage basin plays an integral part of the development process, thereby studying the measurement and mathematical analysis of the Earth's surface, shape and dimension of its landforms (Rekha et al. 2011; Gupta et al. 2019). Morphometric analysis is a quantitative measurement of landscape shape and is carried out through the mathematical analysis of linear, aerial, and relief aspects of the basin (Clark 1966; Keller and Pinter 1996). Morphometric analysis signifies relatively simple methods to designate basin processes and to compare basin characteristics (Horton 1945; Strahler 1952, 1957, Rai et al. 2014, 2017) and has been considerable in any hydrological study like an assessment of groundwater exploration, groundwater management, drainage basin management, and environmental evaluation (Magesh et al. 2013). Quantitative morphometric analysis of watershed can deliver information about the hydrological nature within the basin. A drainage network of the basin provides a reliable index of permeability of rocks and their relationship between rock type, structures, and their hydrological status (Sreedevi et al. 2013; Singh et al. 2014; Rai et al., 2019). Thus, the role of lithology and geologic structures in the development of stream networks can be better understood by studying the nature and type of drainage pattern and by a quantitative morphometric analysis (Nag and Chakraborti, 2003). The morphometric analysis of a drainage basin and its stream system can be better achieved through measurement of linear and shape aspects of drainage network and contributing ground slopes. Though various conventional methods were successfully applied in characterization of drainage basins (Horton 1945; Smith 1950; Miller 1953; Schumm 1956; Strahler 1957; Chow 1964; Raza et al. 1978; Chow et al. 1988) but these were found to be time consuming and difficult, particularly for large areas.

Study Area

The Jammu Himalayas lies between latitude 32^0 33´07´´- 33^0 07´30´´ N and longitude 74^0 27´00´´ - 77^0 21´00´´ E covering an area of 3092 km^2 (Fig.1). Bounded by steep mountain in the north and outer plains in the south and is bounded by Rajouri district in the west, Reasi & Udhampur districts in the north and northeast and Kathua district in the east and southeast. It has Border with Pakistan in the West and southwest. The area comprises of 5 tehsils (Jammu, R.S. Pura, Akhnoor, Samba, and Bishnah) and 12 Blocks and has 1162 villages out of which 119 are uninhabited. The climate of the region is classified as sub-humid to sub-tropical type of climate. The summer season starts from April and lasts till June is followed by southwest Monsoon that has maximum rainfall of the year spread over the months of July, August and September. The post monsoon season (October and November) also experiences some rainfall and is followed by winter season (December-February). The study area falls in sub-mountainous region at the foothills of the Himalayas. This region can be divided in two major units viz. Siwalik ranges (Hilly area) and outer plains. Siwalik range rises gradually in the north part and outer plains merges with the Indo-Gangetic plains in the south. Outer Plains can be divided into Kandi and Sirowal belts. The major rivers flowing through the hilly area of this region are the Basantar, Chenab, Jammu Tawi, and Munawar Tawi. All the rivers are flowing in the northeast to southwest direction.

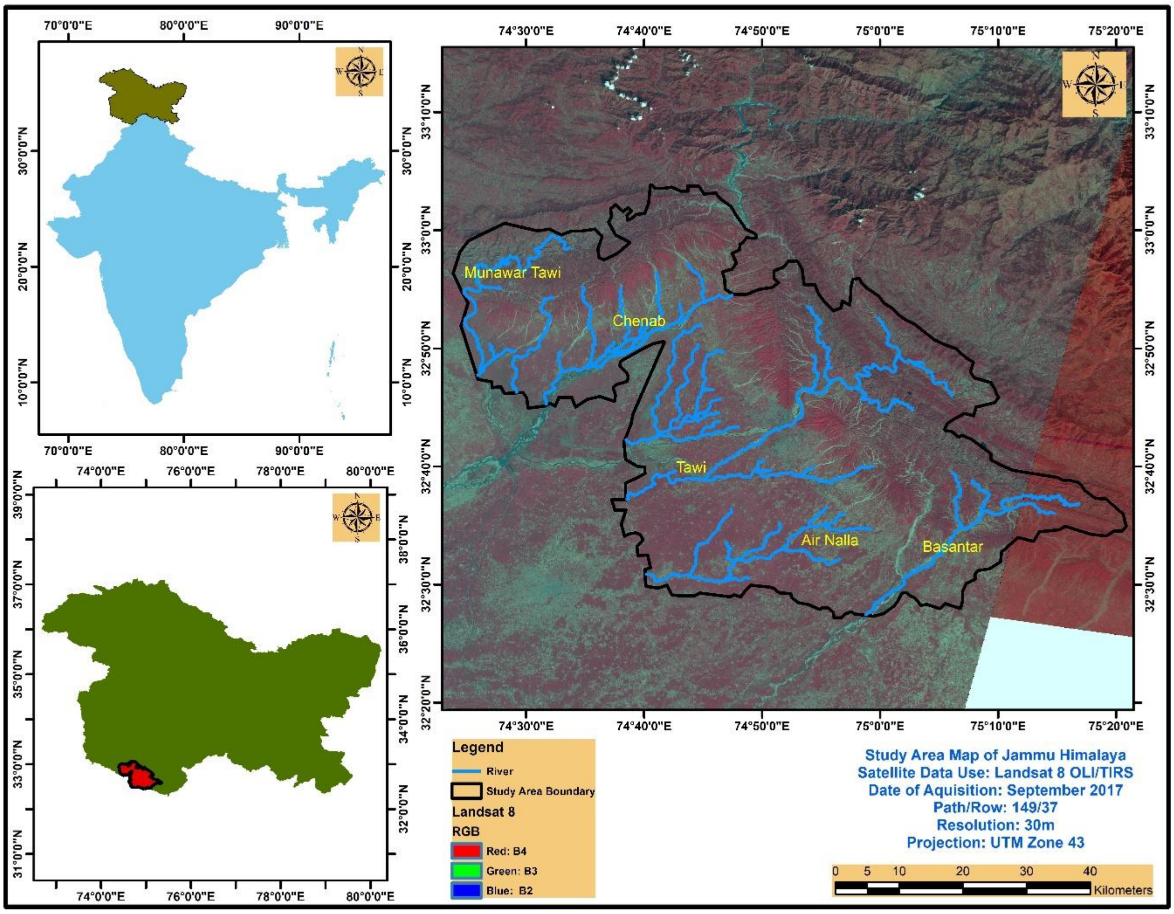


Fig 1: *Location Map of the Study Area.*

Methodology

Assessment of watershed using quantitative morphometric analysis can provide information about the hydrological nature of the rocks exposed within the watershed. A drainage map of a basin provides a reliable index of permeability of the rocks and gives an indication of the yield of the basin. In the present study Survey of India topographical Map (scale 1:50,000) in conjugation with freely available Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Digital Elevation Model (DEM) downloaded from (https://earthexplorer.usgs. gov/) were utilized for extraction and quantification of morphometric parameters. The ASTER DEM with an accuracy of 4.7 m (elevation) and 7.3 m (horizontal) in flat terrains and ~ 7 m (elevation) and 14 m (horizontal) in hilly terrains (e.g.,Muralikrishnan et al. 2013; Kaushik and Ghosh 2015a, b; Patel et al. 2016) is very valuable to derive meaningful inferences regarding morphometric parameters such as area, perimeter, length of the basin, stream order and stream length etc. The other morphological parameters were derived using the mathematical formulae suggested by Horton (1945), Strahler (1957, 1964), Schumm (1956), Miller (1953), and Melton (1965). The list of morphometric parameters estimated and formulae is given in (Fig. 2) and finally, prioritization rating of 15 sub-watersheds of Jammu Himalaya is carried out through ranking the morphological parameters.

Formulae adopted for computation of morphometric parameters

Morphometric Parameters	Formula	Reference
Stream order	Hierarchical rank	Strahler (1964)
Stream length (L_u)	Length of the stream	Horton (1945)
Mean stream length (L_{sm})	$L_{sm} = L_u / N_u$ Where, L_u = Total stream length of order 'u' N_u = Total number of stream segments of order 'u'	Strahler (1964)
Stream length ratio (R_l)	$R_l = L_u / L_{u-1}$ Where, L_u = Total stream length of order 'u' L_{u-1} = Total stream length of its next lower order	Horton (1945)[10]
Bifurcation ratio (R_b)	$R_b = N_u / N_{u+1}$ Where, N_u = Total no. of stream segments of order 'u' N_{u+1} = Number of segments of the next higher order	Schumm(1956)[22]
Drainage density (D_d)	$D_d = L_u / A$ Where, L_u = Total stream length of all orders A= Area of the basin, km^2	Horton (1945)
Stream frequency (F_s)	$F_s = N_u / A$ Where, N_u = Total no. of streams of all orders A= Area of the basin, km^2	Horton (1945)
Texture ratio (R_T)	$R_T = N_u / P$ Where, N_u = Total no. of streams of all orders P= Perimeter of the basin, km	Horton (1945)
Form factor (F_f)	$F_f = A / L_b^2$ Where, A= Area of the basin, km^2 L_b^2 = Square of basin length	Schumm(1956)[23]
Circulatory ratio (R_c)	$R_c = 4 \times \pi \times A / P^2$ Where, A= Area of the basin, km^2 P= Square of the perimeter, km	Miller (1953)[22]
Elongation ratio (R_e)	$R_e = (4 \times A / \pi)^{0.5} / L_b$ Where, A= Area of the basin, km^2 L_b = Basin length, km	Schumm (1956)
Length of the overland flow (L_o)	$L_o = 1/2D_d$	Horton (1945)
Compactness constant (C_c)	$C_c = 0.2821 \times P / A^{0.5}$ Where, A= Area of the basin, km^2 P= Basin perimeter, km	Horton (1945)

Fig 2: *List of Morphometric parameters estimated.*

Geology

The study area is divided into two major geological zones (Fig 3a): (1) Siwalik range (2) Southern outer plains. Siwalik range constitutes about 35% of total area and varies roughly between 400 and 700 m above mean sea level. Siwalik range rises gradually from the northern part of the study area and merges in the south with the Indo-Gangetic plains. On the other hand, southern outer plains lie on the foothills of Siwalik vary between 280 and 400 m above mean sea level. This region is further divided into Kandi in the north and Sirowal in the south. Kandi belt mainly constitutes of Conglomerates, boulders, pebbles, gravels, sandstone with considerable amount of clay and Siwalik rocks formed during Mio-Pliocene age. Sirowal belt comprises of unconsolidated sediments in the form of terraces and coalescent alluvial fans formed due to seasonal streams draining of Siwalik (Fig 3b).

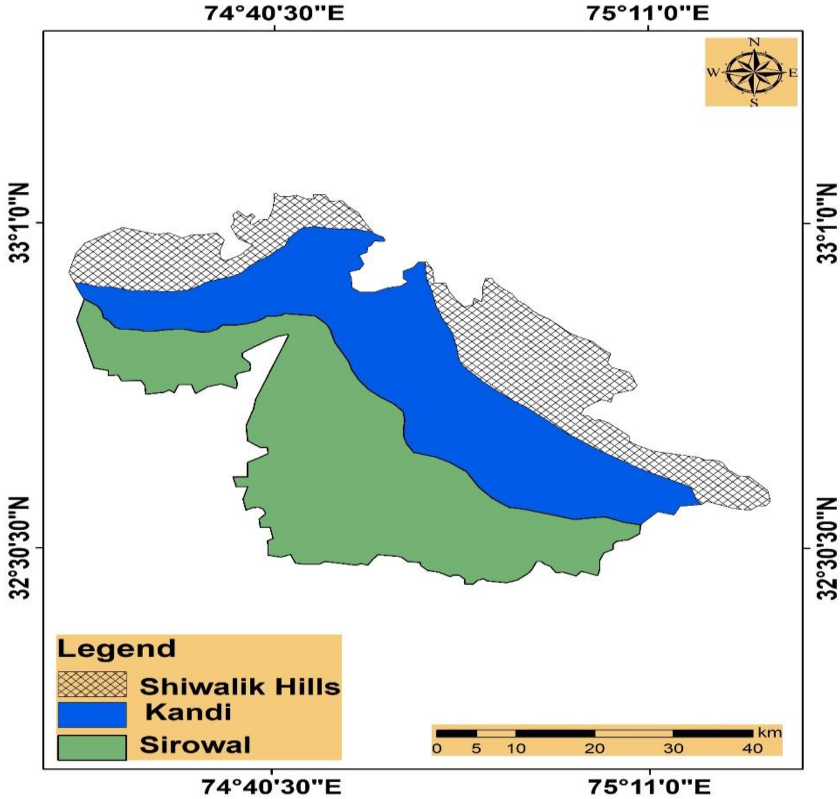


Fig 3(a): *Major geological zones of Jammu Himalaya.*

Kandi (Bhabhar) region: *Coarse grained, Deeper water levels, Higher elevation, GW flows towards Sirowal.*

Sirowal (Terai) region: *Fine grained sediments, Shallow water levels, lower elevation.*

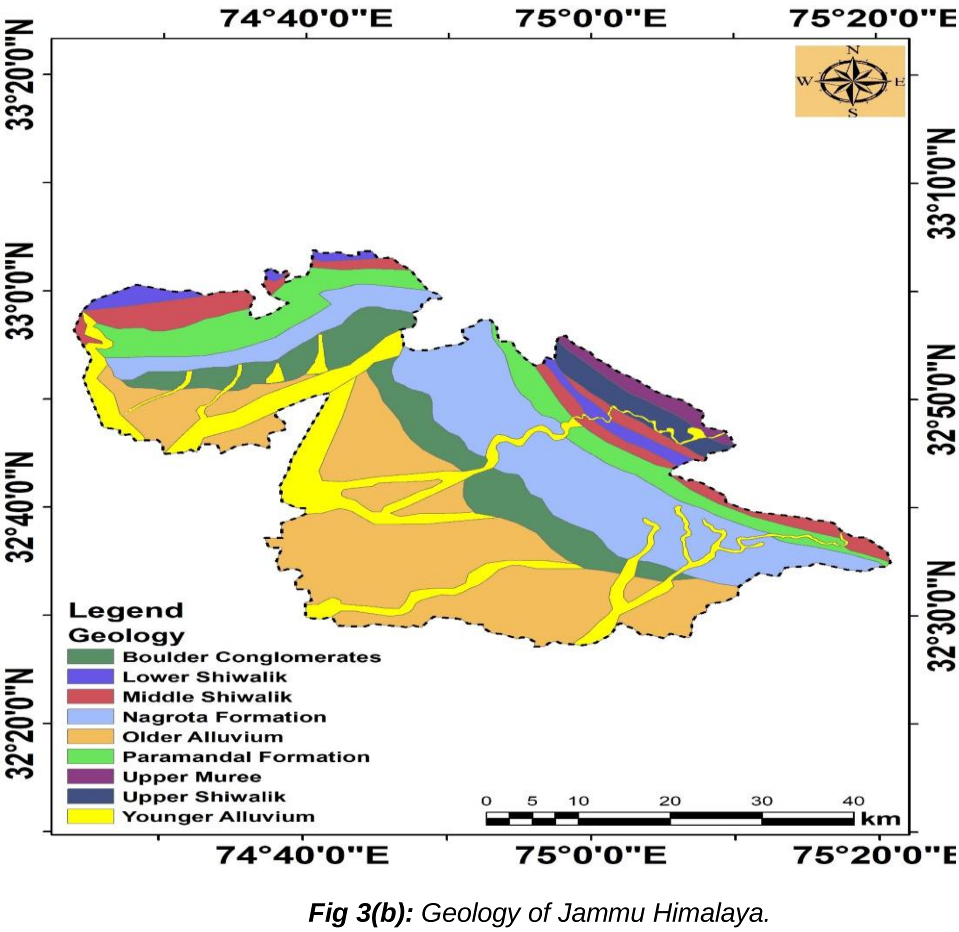


Fig 3(b): *Geology of Jammu Himalaya.*

Drainage Density (D_d)

The surface drainage density of an area can be defined as the ratio of total length of streams divided by total area of drainage basin (Mogaji et al. 2014) and is determined by following equation.

$$\textbf{Drainage Density } (D_d) = \frac{L*n}{A}$$

Where, L is the accumulated length (km), n is the order of the stream, and A is the surface area of the watershed (km^2). Drainage density in a particular region depends upon the both climate and physical characteristics such as type of vegetation, Rainfall, Slope, infiltration, underlying rock type. The study area has been grouped into five classes: 0–0.73 (very high), 0.73–1.15 (high), 1.15–1.52 (moderate), 1.52–1.92 (low), and 1.92–3.06 (very low) km/km^2 (Fig. 4, Fig. 5). Drainage density is an inverse function of permeability and an important parameter for evaluating the groundwater potential zone. It is significant to mention here groundwater prospects are found to be poor in very high drainage density areas due to increased runoff and less infiltration whereas on the other hand low drainage density areas allow more infiltration and less runoff and are identified as high potential for groundwater.

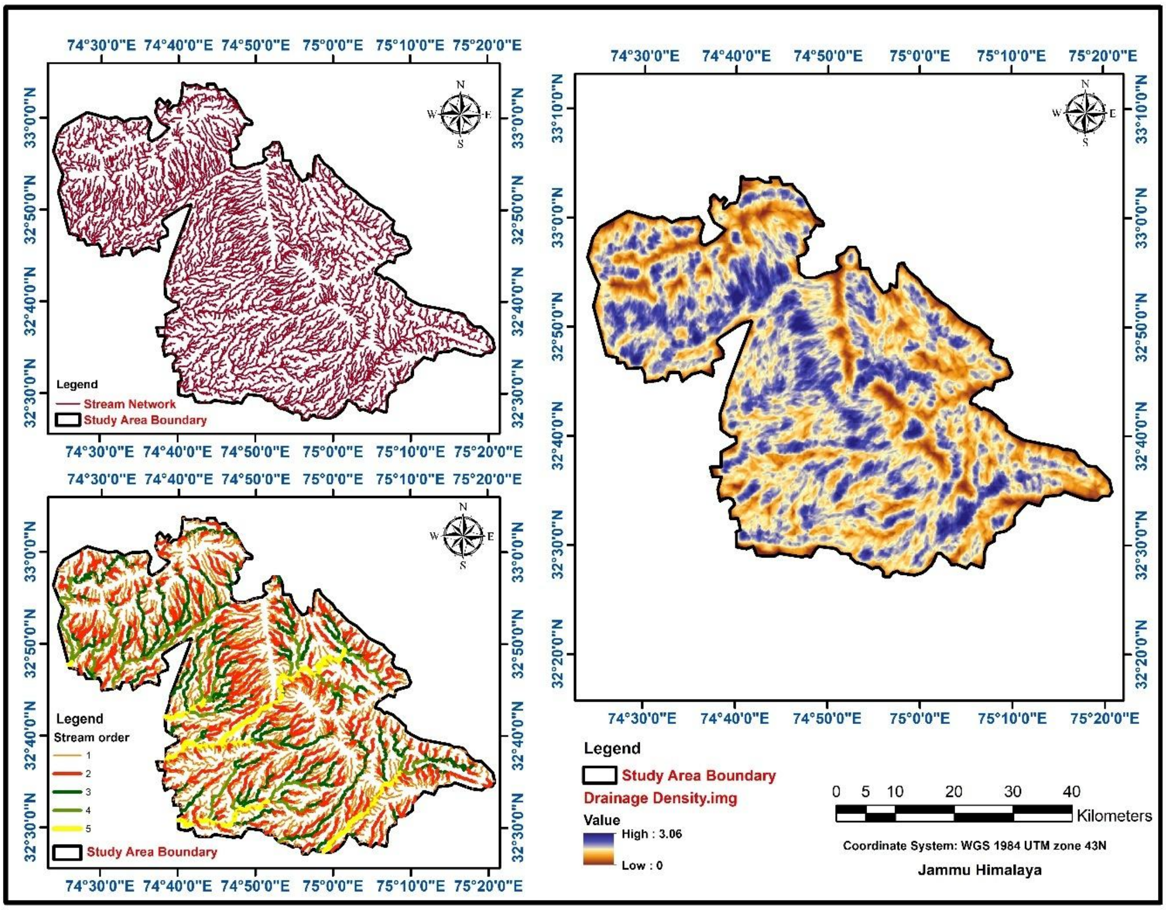


Fig 4: *Stream Network (A), Stream order (B) Drainage density (C) map of Jammu Himalaya.*

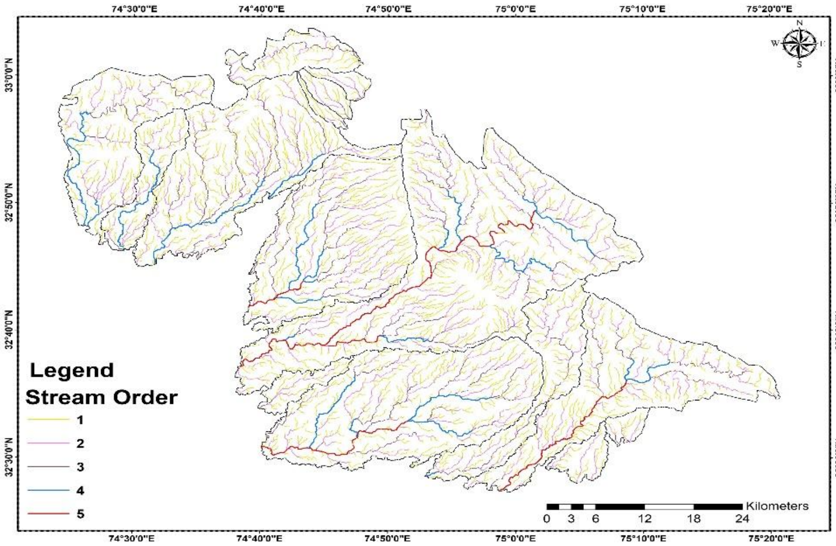


Fig 5: *Stream order.*

Morphometric analysis of Sub-watersheds

Stream Length (L_U)

Stream length is an important factor to understand surface run-off characteristics in a watershed. It is an indicative of chronological developments of stream segments.The small length of the streams indicates an area with large slope and fine texture, and longer length represents flat gradient basins (Oruonye et al. 2016). The stream length of all fifteen sub-watersheds was calculated on the basis of law proposed by (Horton,1945). Stream length of different order under watersheds of the down and upper Narmada basin is given in Table. It is clearly identified that the cumulative stream length is higher in first order streams and decreases as the stream order increases (Table 1a).

Watershed	Basin Area km^2	Stream Length (L_U) (km)					Total (km)	Perimeter (km)	Basin Length (km)
		1	2	3	4	5			
W1	226.28	143.35	81.5	41.03	29.78		295.66	122.24	28.73
W2	83.97	65.65	31.85	7.21	21.04		125.75	79.48	16.36
W3	373.6	296.41	133.28	101.51	34.84		566.04	164.02	38.20
W4	73.77	51.71	22.59	16.33			90.63	71.58	15.20
W5	10.69	12.49	2.2	1.41			16.1	30.85	5.07
W6	21.14	14.9	10.23	2.98			28.11	29.86	7.47
W7	17.04	9.67	8.68	2.43			20.78	29.38	6.61
W8	359.96	277.62	145.89	88.63	30.9	9.19	552.23	133.47	37.40
W9	758	475.34	276.07	114.96	53.82	74.51	994.7	261.88	57.09
W10	35.15	30.64	13.86	2.71			47.21	59.23	9.98
W11	435.33	300.37	145.12	84	41.95	24.74	596.18	153.68	41.66
W12	150.26	110.17	48.11	38.77	1.51		198.56	132.13	22.77
W13	320.17	219.14	103.39	52.53	12.64	28.6	416.3	172.9	34.99
W14	34.14	23	18.89	0.88			42.77	44.58	9.81
W15	18	12.15	8.85	1.68			22.68	27.48	6.82

Table 1a: *Showing results for Stream Length (L_U) (km), Basin Area (km^2), Basin Length (km).*

Stream order

Stream order is an important morphometric parameter as it provides information about the size of the watershed. The stream order for fifteen different sub-watersheds in Jammu Himalaya has been carried out based on the method proposed by Strahler (1964). The streams generally flowing from a high relief points are called first order streams (U) and the stream segments starting from the confluence of two streams are called second order streams (U+1), and so on. In the present study, it is observed that as stream order increases the stream number decreases (Table 1b).

Stream Number (N_u)

The stream number is a total number of stream segments derived from stream order (Strahler 1957). Stream number depends upon the factors such as geology, soil type, slope, vegetation and rainfall in a watershed (Gupta et al. 2019; Sujatha et al. 2015). The presence of more number of streams in a watershed indicates high discharge and causes rapid peak flow during rain storm events. Number of streams of different orders and the total number of streams in the basin are counted and calculated using GIS (Table 1b). During calculation it is identified that the number of streams gradually decreases as the stream order increases; the variation in stream order and size of tributary basins is largely depends on physiographical, geomorphological and geological condition of the region.

Watershed	Number of Streams (N_U)					Total
	1	2	3	4	5	
W1	145	70	47	24		**286**
W2	58	31	8	17		**114**
W3	253	111	96	38		**498**
W4	46	19	21			**86**
W5	5	2	2			**9**
W6	13	8	4			**25**
W7	10	5	4			**19**
W8	215	99	68	25	14	**421**
W9	482	228	104	61	80	**955**
W10	20	13	3			**36**
W11	287	125	73	48	34	**567**
W12	95	39	47	1		**182**
W13	190	81	54	10	35	**370**
W14	9	15	1			**25**
W15	15	10	1			**26**

***Table 1b:** Total Number of Streams (N_U) in Jammu Himalaya.*

Mean Stream Length (L_{sm})

Mean stream length reveals the characteristic size of components of a drainage network and its contributing watershed surfaces (Strahler 1964). It is calculated by dividing the total length of stream segments of an order by the total number of stream segments. The value of L_{sm} differs for sub-watersheds, as it is directly proportional to the size and topography of the basin (Table 1c).

Watershed	Mean Stream Length ($L_{sm} = L_u/N_u$)				
	1	2	3	4	5
W1	0.99	1.16	0.87	1.24	
W2	1.13	1.03	0.90	1.24	
W3	1.17	1.20	1.06	0.92	
W4	1.12	1.19	0.78		
W5	2.50	1.10	0.71		
W6	1.15	1.28	0.75		
W7	0.97	1.74	0.61		
W8	1.29	1.47	1.30	1.24	0.66
W9	0.99	1.21	1.11	0.88	0.93
W10	1.53	1.07	0.90		
W11	1.05	1.16	1.15	0.52	0.73
W12	1.16	1.23	0.82	1.51	
W13	1.15	1.28	0.97	1.26	0.82
W14	2.56	1.26	0.88		
W15	0.81	0.89	1.68		

Table 1c: *Mean Stream Length (L_{sm}).*

Stream Length Ratio (R_L)

Horton's law of stream length states that mean stream length segments of each of the successive orders of a basin tends to approximate a direct geometric series with stream length increasing towards higher order of streams (Table 1d).

Watershed	Stream Length Ratio ($R_L=L_U/L_{U-1}$)				
	1	2	3	4	5
W1	0.57	0.50	0.73		
W2	0.49	0.23	2.92		
W3	0.45	0.76	0.34		
W4	0.44	0.72			
W5	0.18	0.64			
W6	0.69	0.29			
W7	0.90	0.28			
W8	0.53	0.61	0.35	0.30	
W9	0.58	0.42	0.47	1.38	
W10	0.45	0.20			
W11	0.48	0.58	0.50	0.59	
W12	0.44	0.81	0.04		
W13	0.47	0.51	0.24	2.26	
W14	0.82	0.05			
W15	0.73	0.19			

Table 1d: *Stream Length Ratio.*

Bifurcation Ratio (R_b)

The term bifurcation ratio (R_b) is used to express the ratio of the number of streams of any given order to the number of streams in next higher order (Schumn, 1956). Bifurcation ratio characteristically range between 3.0 and 5.0 for basins in which the geologic structures do not distort the drainage pattern (Strahler, 1964). Strahler (1957) demonstrated that bifurcation ratio shows a small range of variation for different regions or for different environment dominates (Table 1e).

Watershed	Bifurcation Ratio (R_b)					R_b
	1	2	3	4	5	
W1	2.07	1.49	1.96			1.84
W2	1.87	3.88	0.47			2.07
W3	2.28	1.16	2.53			1.99
W4	2.42	0.90				1.66
W5	2.50	1.00				1.75
W6	1.63	2.00				1.81
W7	2.00	1.25				1.63
W8	2.17	1.46	2.72	1.79		2.12
W9	2.11	2.19	1.70	0.76		2.00
W10	1.54	4.33				2.94
W11	2.30	1.71	1.52	1.41		1.84
W12	2.44	0.83	47.00			16.76
W13	2.35	1.50	5.40	0.29		3.08
W14	0.60	15.00				7.80
W15	1.50	10.00				5.75

Table 1e: *Bifurcation Ratio (R_b).*

Watershed	Linear Parameters					Shape Factors				
	R_b	D_d	F_u	T	L_0	R_f	B_s	R_e	C_c	C_R
W1	1.84	1.31	1.26	2.34	0.65	0.27	3.65	3.17	2.29	0.19
W2	2.07	1.50	1.36	1.43	0.75	0.31	3.19	2.56	2.45	0.17
W3	1.99	1.52	1.33	3.04	0.76	0.26	3.91	3.53	2.39	0.17
W4	1.66	1.23	1.17	1.20	0.61	0.32	3.13	2.48	2.35	0.18
W5	1.75	1.51	0.84	0.29	0.75	0.42	2.41	1.64	2.66	0.14
W6	1.81	1.33	1.18	0.84	0.66	0.38	2.64	1.90	1.83	0.30
W7	1.63	1.22	1.12	0.65	0.61	0.39	2.57	1.81	2.01	0.25
W8	2.12	1.53	1.17	3.15	0.77	0.26	3.89	3.50	1.98	0.25
W9	2.00	1.31	1.26	3.65	0.66	0.23	4.30	4.11	2.68	0.14
W10	2.94	1.34	1.02	0.61	0.67	0.35	2.83	2.12	2.82	0.13
W11	1.84	1.37	1.30	3.69	0.68	0.25	3.99	3.65	2.08	0.23
W12	16.76	1.32	1.21	1.38	0.66	0.29	3.45	2.90	3.04	0.11
W13	3.08	1.30	1.16	2.14	0.65	0.26	3.82	3.41	2.73	0.13
W14	7.80	1.25	0.73	0.56	0.63	0.35	2.82	2.10	2.15	0.22
W15	5.75	1.26	1.44	0.95	0.63	0.39	2.59	1.83	1.83	0.30

Table 2: *Linear parameters & Shape factors.*

Watershed	Linear Parameters					Shape Factors					Compound Factor	Rank	Priority
	R_b	D_d	F_u	T	L_0	R_f	B_s	R_e	C_c	C_R			
W1	6	9	5	5	7	4	10	10	6	6	6.80	5	**High**
W2	12	4	2	7	3	6	8	8	9	4	6.30	3	**Very High**
W3	4	2	3	4	2	3	13	12	8	4	5.50	1	**Very High**
W4	3	13	8	9	9	7	7	7	7	5	7.50	8	**Moderate**
W5	11	3	12	15	3	12	1	1	10	3	7.10	6	**High**
W6	7	7	7	11	6	9	4	4	1	10	6.60	4	**High**
W7	14	14	10	12	9	10	2	3	3	9	8.60	10	**Low**
W8	10	1	8	3	1	3	12	12	2	9	6.10	2	**Very High**
W9	1	9	5	2	6	1	15	15	11	3	6.80	5	**High**
W10	13	6	11	13	5	8	6	6	13	2	8.30	9	**Low**
W11	5	5	4	1	4	2	14	14	4	8	6.10	2	**Very High**
W12	9	8	6	8	6	5	9	9	14	1	7.50	8	**Moderate**
W13	2	10	9	6	7	3	11	11	12	2	7.30	7	**Moderate**
W14	8	12	13	14	8	8	6	5	5	7	8.60	10	**Low**
W15	15	11	1	10	8	11	3	3	1	10	7.30	7	**Moderate**

Table 3: *Compound Factor, Rank & Priority.*

Annexure-8

H-JRF-8 (Saleem Farooq Rather)

A number of springs in the Jammu region have dried up from past few decades particularly in the regions of Jammu, Samba, Kathua districts. Since there is no available data about the location and number of springs that existed in the past in these areas so the main source of information about the presence of springs in these areas is that collected from the local inhabitants. The local information suggests that there existed hundreds of springs in the past that have dried up now. The spring water used to be the main source of water for domestic purposes like drinking, bathing, washing and cooking. Unsustainable use, overexploitation, deforestation, glacier retreat in recharge area due to climate change, urbanization are among the main reasons that have resulted in the drying up of these springs. The existing springs have been to some extend protected because of the spiritualvalues of a particular religion connected to these springs. The concrete walls around the springs have been constructed to preserve the springs. Construction of concrete walls around the springs have blocked the outflow in some springs which has also resulted in the stagnation of spring water leading to the growth of pathogenic Gram negative bacteria like *E.coli*and *Salmonella*. The water from these springs is used for different domestic and agricultural purposes thus posing a threat to the human health.

Some of the major issues responsible for drying up of springs

1. Ground water level decline: falling trend in ground water table has been observed from last 2 decades (CGWB, 2018) in the Jammu, Samba and Kathua districts. The water level has declined in the range from 2-4 cm.
2. Steep slopes: the slopes towards the South-West Shiwalik hills are steep of the order of more than 20 m per km. The steep slope results in quick runoff of rain water which prevents it from percolating into the ground.
3. Deforestation: due to the growing urbanization and establishment of new industrial areas to meet the growing demands of increasing population, a large area of land has been cleared up of plantation resulting in increased soil erosion and reduction in ground water recharge.
4. Glacier retreat in the recharge area: large numbers of glaciers have been lost due to increasing temperatures because of climate change. This change has resulted in drying up of large number of springs and also decreasing the flow of existing springs.
5. Large number of artesian wells and tube wells: due to the presence of large number of free flowing artesian wells a huge amount of water is extracted and lost, resulting in declining ground water level(Fig 1.1).
6. Dumping of garbage around the springs: garbage is thrown around the springs that are located near or within the residential areas. During the rainy season this garbage is washed into the springs which not only contaminates the water but also chokes the outflow (Fig. 1).

Management/rejuvenation

1. Recharge of ground water: the establishment of recharge pounds and wells can increase the ground water recharge by holding good amount of rain water which could not only help in increasing the ground water level but can also help in rejuvenating the dried up springs and increase the flow of existing springs.
2. Afforestation: Planting more trees in the recharge area can help in reducing the flow of rain water and giving it more time to percolate into the ground.
3. Channelizing the artesian flow: huge amount of water that is lost through the free flowing artesian wells can be channelized to the irrigation canals and utilized for agricultural purpose.
4. Roof top rain water harvesting: the rain water during rainy season can be harvester from roof tops of houses and government buildings and can be stored for use in different purpose

(flushing, gardening etc.) during other seasons which will reduce the burden on tube wells and help in reducing the pressure on ground water.

5. Recharge wells and ponds on the banks of perennial rivers: perennial rivers like Chenab, Tawi, Basanter and Ravi can provide round the year water supply. Ponds and wells on the banks of these rivers in the recharge area can provide a good alternative for recharge of ground water.
6. Open wells: open wells that were used to extract water for domestic and irrigation purpose are now filled with garbage due to coming up of piped water supply. These open wells can be converted into recharge wells.

Microbial load in spring water

Material and methods

Sample collection

Water samples were collected from different springs in sterile 100 ml plastic vials for isolation of bacteria (Fig. 2). The samples were then transported to laboratory for further analysis.

Isolation of bacteria

A four (4) fold serial dilution was prepared using normal saline from collected water samples. 0.1 ml of sample from each dilution was inoculated on pre-prepared EMB agar plates. The media plates after inoculation were incubated at $37^{o}C\pm2^{o}C$ for 24-48 h.

Identification

Morphological approach and Gram's stain

A differential media (EMB agar) was used to check the presence of pathogenic bacterial species. Further macro-morphological approaches like appearance, margin, size and colour were used in addition to Gram's staining for the identification of bacteria.

Biochemical approach

Two different biochemical identification kits from Himedia laboratories, India with cat.no. KB011 and KB010 for *Salmonella* and *E.coli* respectively were used for the identification of bacterial species. These kits include the combination of different tests for identification of *Salmonella* and *E.coli* species. These tests include 1) MR test 2) Voges Proskauer's test 3) Indole 4) Urease production 5) Glucuronidase 6) H_2S production 7) Nitrate reduction 8) Citrate utilization 9) Lysine utilization 10) ONPG test and different carbohydrate utilization tests like 1) Lactose 2) Glucose 3) Sucrose 4) Arabinose 5) Maltose 6) Sorbitol 7) Dulcitol.

Results

As per the morphological and biochemical approach the bacterial species present in the two springs of Jandi and Sherpur were *E.coli* and *Salmonella* species. Growth of bacteria was observed after 24 h to 48 h and the pure culture of the two bacterial species were obtained through sub culturing techniques (Fig. 3).The CFU (colony forming units) per ml for Jandispring I and Sherpur spring I was $3.8\times10^3$and 3.2×10^3respectively. The different biochemical test results (Table 1) showed that the bacterial species belonged to *E.coli* and *Salmonella* species.

Table 1 Biochemical characterization tests for *E.coli* and *Salmonella*

S.No.	Biochemical test	Result	
		E.coli	***Salmonella***
1.	MR test	+	+
2.	VogesProskauer's test	+	+
3.	Indole test	+	NA
4.	Urease production	NA	+
5.	Glucuronidase	+	NA
6.	H_2S production	NA	+
7.	Nitrate reduction	+	NA
8.	Citrate utilization	+	+
9.	Lysine utilization	+	+
10.	ONPG test	+	+
11.	Lactose	+	+
12.	Glucose	+	NA
13.	Sucrose	+	NA

14.	Arabinose	NA	+
15.	Maltose	NA	+
16.	Sorbitol	+	+
17.	Dulcitol	NA	+

+ = Positive; NA = Not Available

(a) **(b)**

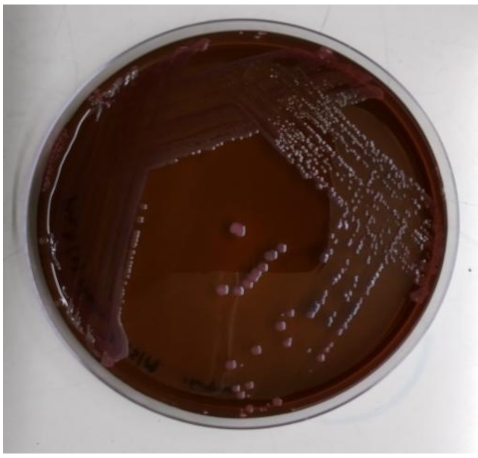
Fig.1. Stagnation of spring water due to no outflow (a); Garbage dumping around the springs (b)

Fig. 1.1 Free flowing artesian well in Jandi area of Kathua district

Jandi spring I

Sherpur spring I

Fig. 2 Collection of water samples from springs.



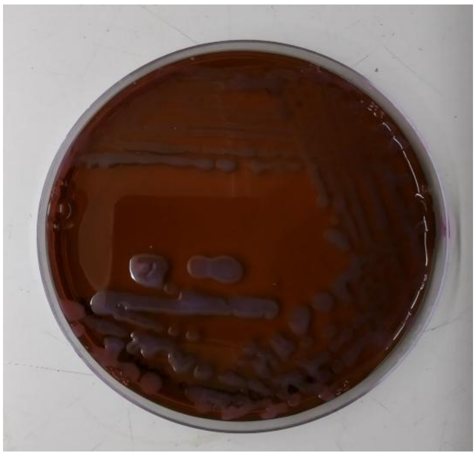


Fig. 3. Images of pure cultures of *E.coli* (left) and *Salmonella* (right) on EMB agar

Conclusion

The presence of pathogenic bacteria in the spring water could be due to the stagnation of spring water by absence of outflow in some springs, bathing inside enclosed spring pool and dumping of garbage around the springs which flows into the spring during rainy season.

Annexure-9

H-JRF-6 (Mohammad Yaseen Mir)

The multifunctional tree species assessed during the field survey included 8 species of *Salix* (Willow), 6 species of *Populus* (Poplar), 2 species of *Juniperus*, *Ephedra vulgaris* and *Hippophae rhamnoides.* These plants were found highly significant to the local population as a source of fodder, fuel and timber besides playing important role in land rehabilitation. The satellite mapping and field observations of Kargil region revealed that the larger area of this region was found to be barren land (44.03 %) followed by vegetation that is 38.59 %. The contour map of Kargil region is shown in Fig 1. The various vegetation types along with their dominant species at different altitudes are shown in Table 1.

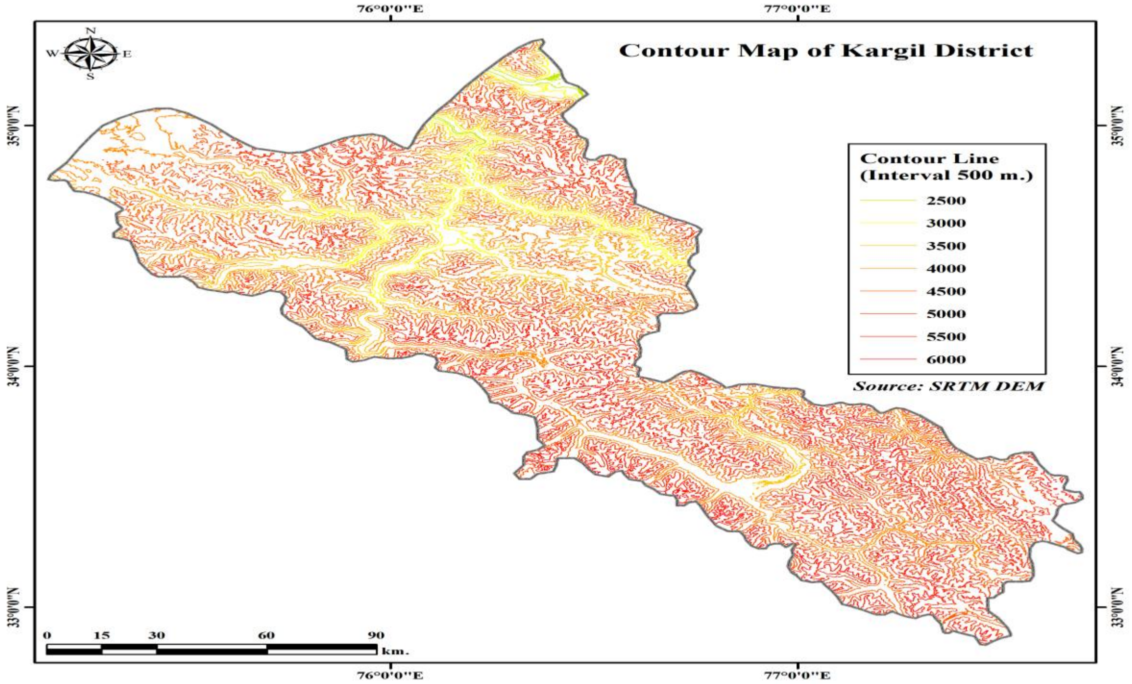


Fig 1. Contour map of Kargil.

Table 1. Vegetation types along with their dominant species

Vegetation class	Altitudinal range (m)	Dominant species composition
Subalpine forest	2,700–3,800	*Juniperus semiglobosa*, *Pinus wallichiana*
Agroforest	2,500–3,600	*Populus* spp., *Salix* spp.
Moist alpine scrub	2,800–5,100	*Hippophae rhamnoides*, *Myricaria germanica*
Moist alpine pasture	2,800–5,800	*Ephedra gerardiana*, *Rheum webbianum*

Annexure-10

H-JRF-7 (Shabana Khurshid)

Roles played by local institutions and Roles description in ladakh Himalayas:

Regulating behavior - the dates and quantities of different kinds of wood allowed for collection from the tsogs is decided by the goba. Maintaining eco system productivity – the institutions help coordinate technological activities e.g use of axes is not allowed in collecting wood from the tsogs. Maintaining the rate of resource use – the quantity of fuel wood to be extracted from the tsogs is decided by the goba in consultation with his members; his decision to a great extend is influenced by the present status of the tsogs (forest groves). Influencing resource allocation- access to the tsogs for collection of wood is given by thalpa households only (those households who contribute labor in village level community work). Ensuring access to scare resources- the appointment of monitoring agency and enactment of norms ensures access to the tsogs resources.

Results:

It was observed that age old system of pilgramage to the holy shrine has drastically changed from the past.Decades before the rush to the holy cave used to be less and the medium of transportation either being ponies/palki/or tracking by foot has partly been replaced by helicopter services which is more efficient and effective means of transportation but due to the addition of such services, the influx of the piligrams has increased manifold as it has made the piligramage easier but pressing of such services is somewhere posing threat to environment of himalayas. The human waste which is spread during the piligramage hardly gets any proper treatment as such the environment gets polluted.

Ladakh serves as an example as how even in the wake of changes due to modernization and industrialization and harsh climate it has managed to share the responsibility of these changes which has led to sustainable development in the region. However, the recent trened in the development suggets that if it follows the same path as other econmies have it will also have same future.The rapid industrialization and globalization has affected all the regions in the world even those who were far off and remote. Ladakh is also affected and has seen the effects of the indusrialization which promised development. For very long period of time everything that was needed by Ladakhis was produced locally hence it helped them minimise the effects of industrialization. They don’t waste anything and even the waste produced is also re-cycled and re-used. Ladakhi life are highly influenced by the Buddhist teachings. They respect the limited resources they have and use it to the fullest to meet their needs and demands. The industrialized soceities have created monoculture and increased consumerism and suggests that there is only one model for development which is western model of development. But the example of Ladakh, challenges this notion and suggests alternative model of development which is not free of challenges. The study will further evaluate various measures corresponding to sustainable resource management and will establish a co-relational analogy between a scientific/sustainable resource management and socio-economic development of the social habitat around.

New Study Areas Identified:

- Likir.
- Karu.
- Hemis.
- Chumathang.
- Nee.
- Panamik.
- Tangya.
- Tingmosgang.
- Khaltse.
- Nurla.
- Domkhar.
- Skurbuchan.

Objectives to be completed:

- Community Contribution in Protection of Traditional Institutes for Environment Protection in Ladakh Himalayas.
- Conservation through Integration of Traditional & cultural values Of Ladakh.
- Adaptive Significance of *Social Institutions* in this *Environment protection in ladakh.*
- *Climate* Change Impacts to Disrupt *Traditional* Subsistence Systems in ladakh.

Conclusion :

Comprehensively and critically analyzing the role and impact of various institutions and programmes that have their focus on environmental apprehension. In the management of the resources all the stakeholders are involved and peer monitoring and self-restrain are the major monitoring mechanism successfully being implemented due to the higher interdependency among appropriators and physical proximity to the resource.The futuristic intervention will be purely based on a well-established research based study that would include a well thought out and well versed research design. The cause and effect analogy of the variables in question would be scientifically done through a grass root level operationalization of variables to validate and authenticate the applicability of the hypothesis. In furtherance, an insinuated effort will be put to comprehensively analyze the role and impact of various institutions and programmes (both governmental as well as non-governmental) that have their focus on environmental apprehension and what has been the progression or regression made so far in this regard. Due to political disturbances, administrative shifting and reorganization bill corroboration of the observation with the information/data couldn't be made possible.

Annexure-11

H-JRF-9 (Nafiya Qadir)

Introduction

Ladakh is situated approximately 3000m above sea level and nature has endowed it with a rough terrain as it comes under the Himalayan range of high elevation. Greater Himalayas isolate this very mountainous region from the rest of the country and on its northern side lies the Karakoram range (Dame and Nusser, 2011). Ladakh is divided into two districts namely Leh and Kargil. Each region experiences unique environmental challenges such as strong sunlight, more transpiration, erratic wind and unconditional temperatures that lead to less precipitation in the form of rain and hence arid type floral pattern that altogether produce harsh and non-conducive environment for survival of mankind. Rugged topography and extreme snowy precipitation during cold season are the common factors that are responsible for reduced accessibility of the region for almost half a year (Angchuk and Singh, 2006). Single cropping season from May-September is suitable for agricultural production while during the remaining months (winter), shortage of horticultural and agricultural commodities is common. Reduced availability of food resources in the region leads to development of deficiency of essential nutrients among inhabitants (Tamang, 2010). In order to combat malnutrition, people of Kargil have inculcated the habit of developing several indigenous food products since ages for their survival under harsh environment. As per the European Commission (2007), the trend of preparing traditional foods keeps on passing from ancestors to coming generation and this process has been going on since ages and will continue in future also. It is very much essential to document information related to traditional food products for preserving cultural aura of the country (Panda et al., 2016).

2. Review of literature

The preparation technique of food products in Kargil coincide with those prepared in North Eastern parts of India. For example, *churrp*i is a traditional cottage cheese of Sikkim, Darjeeling, Ladakh etc. The sample of *churrpi* collected from Leh region of Ladakh was analyzed for chemical composition and microbiological profile by Panda et al. (2016). It was found by the researchers that this cheese was rich source of proteins (60-63%), B and C vitamins, organic acids and included *Lactic acid bacteria* and *Bifidobacterium* sp., as microorganisms responsible for cheese preparation. In 2008, Dame and Nusser (2011) conducted survey of a village called Hemis Shukpachan which was 40 km far from Leh district of Ladakh and noticed that the frequency of consumption of food items such as *thukpa*, *skyu* and *paba* increased in winter while consumption of tagi, fresh vegetables and kholak increased with the onset of summer season. Literature also contains some brief information about soups such as *jamthuk*, *pakthuk* and *ngamthuk* prepared from barley flour, wheat flour and meat. Little information is also available in literature about various forms of *kholaks* namely *phemar*, *tsiri kholak* and *namphey* being prepared in the entire Ladakh region (Angchok et al., 2009). Among fruits, apricots contribute as major economic boon for the people of Ladakh (Dwivedi et al. 2007). Traditional method for the extraction of apricot kernel oil by the tribal people of Ladakh has been explained in literature. Oil constitutes more than 50% composition of apricot kernels followed by proteins (30%) while sugars, fiber and ash constitute the remaining portion (Dwivedi and Deepa, 2004). Sweet kernel oil is consumed by the people just like other edible oils in several foods such as its use for the preparation of *phemar* that consists of a mixture of barley flour, oil, saline tea with some sugar (Targais et al., 2011). There is some information also available regarding other products such as *chulphey* which is a mixture of apricot powder and barley flour (Hussain et al., 2012). Researchers have done documentation of some indigenous milk products that are prepared across Ladakh area of the Himalayan region. Preparation, composition and microbiological profile of food products namely *jho*, *taro*, *labo*, *tuth* etc have been documented (Raj and Sharma, 2013).

Study area and methods

The study area for the current investigation was Kargil region of Ladakh. Kargil lies at an average elevation of 2676 metres above sea level and is situated along the banks of river Suru, a tributary of Indus. It lies between 30-35° North latitude and 75-77° East longitude and occurs in the Western Himalayan region. Documentation of indigenous foods products prepared in Kargil was conducted through primary survey i.e. discussion with the villagers and on-spot observation of method practised by the villagers, questionnaires, interviews and through secondary source of data i.e. journals as well.

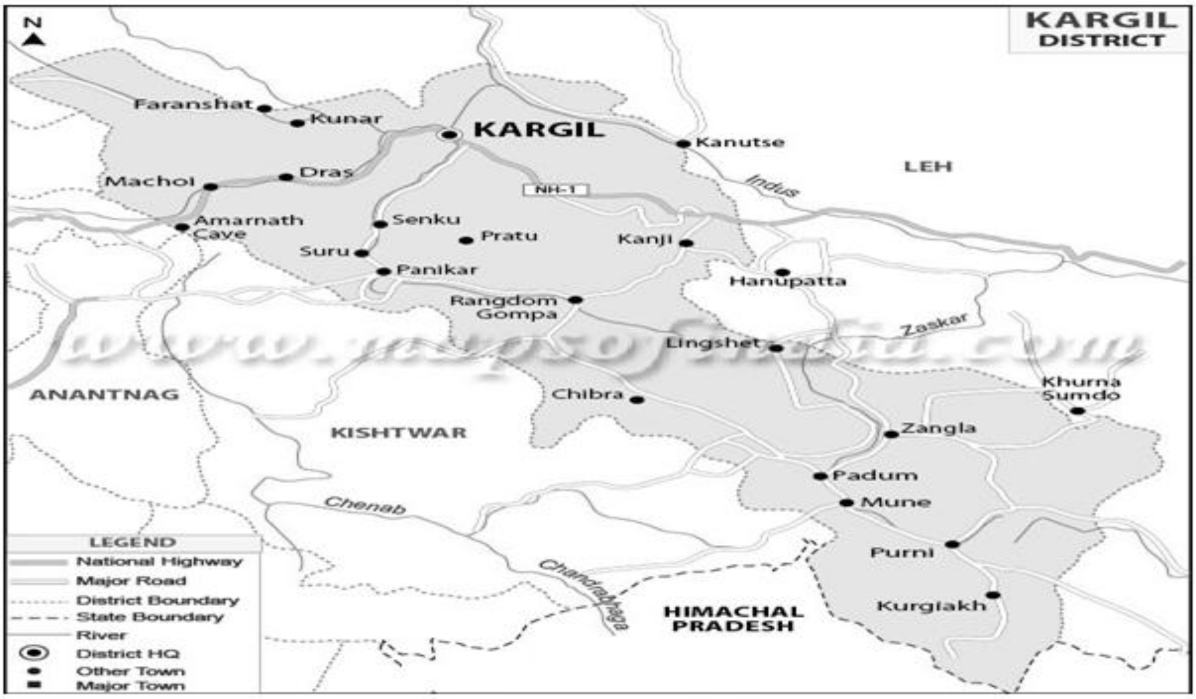


Fig. 1: Map of Kargil

Results and discussion

The indigenous food products prepared by the people of Kargil were grouped into three categories on the basis of source taken for their preparation as mentioned below:

A. Cereal based products

1.. ***Tsap-thuk***: Pre-germinated barley flour is called '*Tsap*'. For the preparation of *Tsap-thuk*, barley grains are conditioned and kept in sunlight till germination takes place. The germinated barley grains are dried in sun and ground to flour. Cooking of flour is done in water without addition of seasonings. It is mostly consumed during winter months and is considered to be beneficial for stomach health.

2. *Kholak*: *Kholak* is a dish prepared by processing of barley. Barley grains are washed and dried. Then they are roasted on sand bath and sieved. The roasted grains are ground to flour and mixed with tea, butter or ghee in appropriate ratio to get thick consistency '*Kholak*' which is then served with any drink, meat or vegetable preparation.

3. *Paba*: '*Paba*' a pudding, is prepared by mixing cereal grains with legumes followed by their roasting and grinding that yields flour. The flour is cooked inside a stone utensil to make the pudding. Paba is made from cereals like barley and legumes such as pea. Barley and pea are cleaned to remove unwanted materials, washed and dried. After that the material is half roasted on sand, sieved and ground to flour. The resulting flour is slowly added to boiling water, stirred constantly till dough like material is formed. It is served hot or cold with vegetables, meat, milk or curd.

4. *Marzan*: For its preparation, barley is ground to flour and placed in boiling water with stirring until it becomes a solid gel. This solid gel is mixed with butter or ghee and served along with breakfast tea. Marzan is one of the traditional foods of the tribal population.

5. *Kaptsey*: This is a type of bread prepared from wheat flour. For its preparation, kneading of the flour to dough is done by adding water to it. Then round ball of dough is flattened, turned, twisted and pressured to obtain a sort of interlocked network. It also involves addition of sugar to give the bread its sweet taste. Then the prepared raw bread is allowed to cook in oil. This type of bread is distributed by the people of Kargil to their relatives on special occasions.

6. *Sephe Tagi*: This is a type of bread made from sprouted wheat. It is prepared during onset of spring season. The grains are allowed to germinate and ground using pestle and mortar. Water is added to broken sprouts and ground grain mixture is added to flour for dough formation. Hot stone is used as the heating medium for cooking of this bread. Heating causes puffing of dough into cooked bread.

B. Dairy products

1. *Derba*: It is the buttermilk produced by people in Kargil. It is prepared by boiling and cooling milk or by heating it to a temperature of 40-45°C and inoculating it with a previous batch of buttermilk. The product is incubated overnight at a warm place till curd formation is completed. Buttermilk is prepared by churning curd in a special wooden vessel called 'zem'.

2. *Maar*: It is the butter that is prepared by the rural people of the region in addition to adjoining areas. Butter is prepared by churning curd and filtering the by-product i.e. buttermilk through the cheese cloth. The prepared butter after solidification is packed in bags made of goat skin that keeps it shelf stable for upto 1 year. This butter is a good source of fat soluble vitamins like vitamin A and D.

3. *Churrpe*: *Churppe* is the dried cottage cheese. For its preparation, whole milk from female yak (*dzomo*) is boiled for nearly 15 minutes in a container. Starter culture is added to it after lowering of temperature to 40°C and milk is allowed to curdle at ambient temperature for 6 hours. The resulting curd is churned for few minutes to separate the fat from the liquid. This liquid product is called tara or buttermilk. Tara is boiled for 1-2 hours for protein coagulation. The coagulated product is hung in cheese cloth for proper drainage of whey. The solidified product is mixed manually and pressed in between the fingers to obtain the desired shape. The product can be consumed fresh as well as in dried form. Product drying is carried out in sun for 5-6 days so as to form hard *churrpe*.

4. *Thud*: It is butter and dried cheese brick prepared by mixing butter, ground dried cheese and sugar together. The resulting mixture is moulded into a brick and has long shelf life under cold climatic conditions.

C. Beverages

1. *Gurgur cha and Kunak*: It is also known as salted butter tea. This form of tea is prepared locally by mixing tea, salt, butter and milk. The tea leaves are boiled to obtain tea extract which is then filtered. All ingredients are placed in a wooden churn locally called ʽdongmoʼ and churned with the help of churner. The finished product is kept in copper pots and served. The filtered tea extract known as cha-thang can be stored for several days. Tea can be made by simply mixing diluted extract together with ingredients mentioned above. Product has been named after the peculiar sound produced upon churning. Kunak, a form of black tea specifically consumed in Kargil is prepared by boiling tea leaves in a vessel to obtain concentrate. From this, suitable quantity of concentrate is taken which is diluted with water and later salt is added to it and allowed to boil to get tea.

2. *Chulli chhu* and ***Tsigu chhu***: The major horticultural produce of Kargil region is apricot. Apricots grown in the region are of superior quality than other places. People of this region preserve apricots by drying them at their roof tops. This uncontrolled drying technique lowers the quality of product. At some regions, solar driers have also been installed that deliver dried product of superior quality. The apricots produced are consumed in fresh, dried or in processed form. ʽ*Chulli'* is a variety of apricot that is destoned and dried. Later on, the dried apricot is processed into juice which is called ʽ*chulli chhu*ʼ in local language. *Tsigu chhu* is a drink made from apricot kernels. Such type of drink is prepared by grinding apricot kernels and mixing them with water.

Conclusion and recommendation

From the survey, it can be concluded that there are large number of indigenous food products being processed in a unique manner by the local people of Kargil area of Ladakh. These food products come under different categories depending upon the source used for preparing them. From past analysis, it was observed that barley and wheat constitute the major cereal grains grown in the area that are utilised for preparation of various types of bread, roasted flours or simply as meals. Besides these, a number of fermented products using milk or curd as base materials such as *churrpe*, *maar*, *thud* etc are also produced locally. Fermented food products are a rich source of vitamins, proteins, fat and minerals that fulfill the nutritional requirements of the people under scarcity of fresh agricultural and horticultural produce during harsh season that lasts not less than six months. Also, economy of the region depends upon export of dried apricots to other parts of the country. Salted tea beverages such as *gurghur cha* and *kunak* are some unique preparations of Kargil for refreshment.

Table 1: Some traditional foods and beverages of Kargil

Traditional foods and beverages	Type of product	Ingredients
Cereal based products		
Marzan	Cereal	Barley, butter or ghee
Kholak	Roasted flour	Roasted barley, butter or ghee
Kaptsey	Bread	Wheat flour, oil, sugar and water
Paba	Pudding	Barley, pea

Sephe Tagi	Bread	Sprouted wheat flour
Tsapthuk		Pre-germinated barley flour
Milk based products		
Thud	Butter and dried cheese	Butter, dried cheese and sugar
Churrpe	Cottage cheese	Milk, starter culture
Maar	Butter	Curd
Derba	Buttermilk	Milk
Beverages		
Gurghur cha	Salted butter tea	Tea, salt, butter and milk
Kunak	Black tea	Tea leaves, salt
Chulli chhu	Apricot juice	Dried apricots
Tsigu chhu	Apricot kernel drink	Apricot kernels, water

(Signature of Registrar/ Head of Department)

Report (hard copy) should be submitted to:

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G.B. Pant National Institute of Himalayan Environment and Sustainable Development (GBPNIHESD)
Kosi-Katarmal 263 643, Almora, Uttarakhand

Report (soft copy) should be submitted to:

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