Vol 3 Issue 11 Dec 2013
ISSN No : 2230-7850

International Multidisciplinary
Research Journal

Indian Streams Research Journal

Executive Editor
Ashok Yakkaldevi

Editor-in-Chief
H.N.Jagtap

Welcome to ISRJ

RNI MAHMUL/2011/38595 **ISSN No.2230-7850**

Indian Streams Research Journal is a multidisciplinary research journal, published monthly in English, Hindi & Marathi Language. All research papers submitted to the journal will be double - blind peer reviewed referred by members of the editorial board.Readers will include investigator in universities, research institutes government and industry with research interest in the general subjects.

International Advisory Board

Flávio de São Pedro Filho
Federal University of Rondonia, Brazil

Kamani Perera
Regional Center For Strategic Studies, Sri Lanka

Janaki Sinnasamy
Librarian, University of Malaya

Romona Mihaila
Spiru Haret University, Romania

Delia Serbescu
Spiru Haret University, Bucharest, Romania

Anurag Misra
DBS College, Kanpur

Titus PopPhD, Partium Christian University, Oradea,Romania

Mohammad Hailat
Dept. of Mathematical Sciences, University of South Carolina Aiken

Abdullah Sabbagh
Engineering Studies, Sydney

Catalina Neculai
University of Coventry, UK

Ecaterina Patrascu
Spiru Haret University, Bucharest

Loredana Bosca
Spiru Haret University, Romania

Fabricio Moraes de Almeida
Federal University of Rondonia, Brazil

George - Calin SERITAN
Faculty of Philosophy and Socio-Political Sciences Al. I. Cuza University, Iasi

Hasan Baktir
English Language and Literature Department, Kayseri

Ghayoor Abbas Chotana
Dept of Chemistry, Lahore University of Management Sciences[PK]

Anna Maria Constantinovici
AL. I. Cuza University, Romania

Horia Patrascu
Spiru Haret University, Bucharest,Romania

Ilie Pintea,
Spiru Haret University, Romania

Xiaohua Yang
PhD, USA

......More

Editorial Board

Pratap Vyamktrao Naikwade
ASP College Devrukh,Ratnagiri,MS India

R. R. Patil
Head Geology Department Solapur University,Solapur

Rama Bhosale
Prin. and Jt. Director Higher Education, Panvel

Salve R. N.
Department of Sociology, Shivaji University,Kolhapur

Govind P. Shinde
Bharati Vidyapeeth School of Distance Education Center, Navi Mumbai

Chakane Sanjay Dnyaneshwar
Arts, Science & Commerce College, Indapur, Pune

Awadhesh Kumar Shirotriya
Secretary,Play India Play,Meerut(U.P.)

Iresh Swami
Ex - VC. Solapur University, Solapur

N.S. Dhaygude
Ex. Prin. Dayanand College, Solapur

Narendra Kadu
Jt. Director Higher Education, Pune

K. M. Bhandarkar
Praful Patel College of Education, Gondia

Sonal Singh
Vikram University, Ujjain

G. P. Patankar
S. D. M. Degree College, Honavar, Karnataka

Maj. S. Bakhtiar Choudhary
Director,Hyderabad AP India.

S.Parvathi Devi
Ph.D.-University of Allahabad

Sonal Singh,
Vikram University, Ujjain

Rajendra Shendge
Director, B.C.U.D. Solapur University, Solapur

R. R. Yalikar
Director Managment Institute, Solapur

Umesh Rajderkar
Head Humanities & Social Science YCMOU,Nashik

S. R. Pandya
Head Education Dept. Mumbai University, Mumbai

Alka Darshan Shrivastava
Shaskiya Snatkottar Mahavidyalaya, Dhar

Rahul Shriram Sudke
Devi Ahilya Vishwavidyalaya, Indore

S.KANNAN
Annamalai University,TN

Satish Kumar Kalhotra
Maulana Azad National Urdu University

Address:-Ashok Yakkaldevi 258/34, Raviwar Peth, Solapur - 413 005 Maharashtra, India
Cell : 9595 359 435, Ph No: 02172372010 Email: ayisrj@yahoo.in Website: www.isrj.net

Indian Streams Research Journal
Volume-3, Issue-11, Dec-2013
ISSN 2230-7850

Available online at www.isrj.net

Hydro-meteorological Aspect Of Climate Change On Natural Hazards With Proposed Adaptation And Mitigation Strategies In North-western India

Sandeep Kumar and Santosh

Department of Environment Studies, Panjab University, Chandigarh.
Department of Environmental Sciences, MDU, Rohtak (Haryana).

Abstract:-*Climate change is generally defined as the long term significant change in the average weather condition of a specific region or zone over an appropriately significant period of time. The fourth assessment report of IPCC reported that the average global temperature has increased by 0.6°C over 20th century and projected will be 1.8-4.0°C by 2100s (IPCC, 2007). The globally averaged surface temperature is projected to increase by 1.4°C to 5.8°C over the period 1990 to 2100 (IPCC, 2013). Conclusion of various studies shows that the surface temperature in India was increased with considerable regional variations i.e. 0.5 to 0.6°C during 1901-2005 and the projected will be 2-5°C by 2100s. Climate change, whether driven by natural or human activities, can lead to changes in the likelihood of the occurrence or strength of extreme weather and climate events. The weather pattern have become more extreme, with more frequent and more intense in rainfall events, subsequent floods and prolonged droughts i.e. the intensity and frequency of hydro-meteorological hazards has increased. Climate change has the potential to impact the hydrological cycle and subsequently the hydro-meteorological disasters. The vulnerability and associated risks in North-Western parts of India are increasing as over 90% of natural disasters in this region are hydro-meteorological in origin. The paper highlights the climate change and its impact on hydro-meteorological hazards in NW India. The paper also suggest various mitigation and adaptation strategies to cope with impacts of climate change on hydro-meteorological disasters such as capacity building and increasing resiliency among vulnerable communities along with adoption of sustainable development approach.*

Keywords:Adaptation, Climate change, Hydro-meteorological disasters, Mitigation, Sustainable development, Vulnerability.

INTRODUCTION

Climate change is generally defined as the long term significant change in the average weather condition of a specific region or zone over an appropriately significant period of time. Climate change in IPCC usage refers to any change in climate over time, whether due to natural variability or as a result of human activities. This usage differs from that of UNFCCC which defines climate change as, “a change of climate which is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and which are in addition to natural climate variability observed over comparable time periods”. Climate change is now recognised as one of the most important environmental challenges faced by humanity. The scientists, politicians and media are vociferous that the drastic change in climate is imminent, with disastrous effects. Changes in the climate occur as a result of both internal variability within the climatic system and external factors, both natural and anthropogenic. It is difficult to clearly delineate the characteristics of climate change associated with natural and anthropogenic forcing due to complex interaction within the climatic system.

Presently, climate change is mainly caused by anthropogenic emissions of greenhouse gases (GHGs) due to unrestricted use of fossil fuels. Since the beginning of industrial revolution, human activities have lead to unprecedented changes in the chemical composition of earth's atmosphere. Global concentration of greenhouse gases has increased exponentially since the advent of industrial era (Dentener *et al*., 2001). The increase in radiative forcing of the atmosphere due to increase in greenhouse gases concentration results in the warming of the earth's surface (Meehl *et al.,* 2005). The global atmospheric concentration of carbon dioxide and other green house gases have dramatically increased over the 20th century. During this century, there is increase in carbon dioxide concentration from 280 ppm to 379 ppm. Though, the presence of these gases in atmosphere is essential for maintaining the global temperature at 15°C, otherwise it will be -17°C (Houghton et al., 2001). But the increase in concentration have enhances the average global temperature.

Historically, the responsibility of emission of greenhouse gases lies largely with the industralised world, though the developing countries are also responsible as the important source of increasing emissions. There is new and stronger evidence that most of the warming observed over the past 50 years was attributable to human activities (IPCC, 2001a). Warming in the NW region of India has been much greater than global average. Both increasing and decreasing rainfall patters have been detected in the area. Weather patterns are becoming more unpredictable and extreme. The vulnerability and associated risks arising from change in climatic conditions in the region are increasing as over 90% of natural disasters are hydro-meteorological in origin. These disasters disrupt the basic functioning of the community by affecting their socio-economic conditions (loss of life supporting system) along with environmental loss and affect the human development as a whole.

North-Western region of India

The North-Western region of India comprised of Jammu and Kashmir, Himachal Pradesh, Punjab, Haryana, Rajasthan, Uttarakhand, Delhi, union territory of Chandigarh and parts of Uttar Pradesh. It lies mainly on continental Indian part, north of peninsular India. Towards its North are the Himalayas which define the boundary between the Indian subcontinent and the Tibetan plateau. Its Western side is covered by Thar desert, shared between North India and Pakistan and the Aravalli Range. The predominant geographical features are the Indo-Gangetic plain which spans the states of Punjab, Haryana and Uttar Pradesh; the mountains which lie in the states of Uttarakhand, Himachal Pradesh, Jammu & Kashmir and the desert which lies mainly in the state of Rajasthan.

Figure 1. Location map of North-Western region of India.

Trends in climate change

The global and regional trends are observed by scientists and researchers through various models. According to fourth assessment report of Intergovernmental Panel on Climate Change, the global average temperature of the earth was increased by 0.6°C over 20th century. The projected temperature will be 1.8°C to 4.0°C by the end of 20th century. Over the last 50 years, the rise in temperature was 0.1°C per decade and expected will be 0.2°C per decade. By the end of the 21st century, the most likely increases are 3 to 4°C for the A2 emission scenario and around 2°C for B1 (IPCC, 2007). The globally averaged surface temperature is projected to increase by 1.4°C to 5.8°C over the period 1990 to 2100 (IPCC, 2013).

In India, there is increasing trends in surface temperature (Rupakumar *et al.*, 1994; Pant et al., 1995; Singh et al., 2003). From the various studies, it was found that the surface temperature in the Indian region was increased by 0.5°C to 0.6°C during 1901 to 2005, with considerable regional variations. The projected ambient temperature will be 2°C to 5°C by the end of 21st century. Studies show that the heating of atmosphere will not be uniform across the country. The winters of North and Northwest India may be more than 2°C warmer by the mid of 21st century. The monsoon season is likely to about 1°C warmer, on an average (Lal, 2001). Warming of the Indian sub-continent by 0.4°C over the period 1901–1982 was reported by Hingane et al. (1985), indicating that this warming since 1900 is broadly consistent with observed global warming over the last century. IPCC (1990) reported that the warming will be between 1 and 2°C by 2030 in the Indian region. Lal and Singh (2001) reported that the average annual mean surface temperature is likely to increase by about 2.7°C and 3.8°C during the decades of 2050s and 2080s, respectively. Moreover, it is likely that over inland regions, the mean surface temperature may rise between 3.5 and 5.5°C by 2080 (Lal, 2001).

Impacts of climate change on hydro-meteorological hazards

The hydro-meteorological disasters are not stranger to the NW India. The region is periodically visited by various weather related disasters. Climate change is now adding significant additional threat to the already volatile risk prone areas by increasing the intensity and frequency of water related natural hazards. The vulnerability and associated risks in the region are increasing especially towards climate change induced hydro-meteorological disasters in space and time. These hazards left adverse impacts on the socio-economic condition of the people and the damage to the physical infrastructure along with deterioration of environmental conditions.

Both, global and regional models have been used for producing climate change scenarios for Indian subcontinent. The latest version of Hadley Centre Regional Climate Model, PRECIS has been used to generate the climate for the present (1961-1990) and a future period (2071-2100) under two different scenarios of emissions. The study results indicate an all-round warming over the Indian subcontinent associated with increasing greenhouse gas concentrations, and also a slight increase in summer monsoon precipitation. It is projected that rainfall will increase by the end of the 21st century by 15-40%, and the mean annual temperature will increase by 3°C to 6°C.The warming is more pronounced over land areas, with the maximum increase over northern India. The warming is also relatively greater in winter and post-monsoon seasons. Spatial patterns of rainfall change projections indicate maximum increase over northwest India (Gupta *et al.*, 2009). The monsoon rainfall at all India level does not show any trend but there are some regional patterns. There is an increasing trend in the monsoon rainfall over the North-West India. However, the spatial distribution of temperature changes indicates a cooling trend in the region (Gupta et al., 2009).

The well recognised physical consequences of climate change are on the hydrological cycle and other related processes. The hydrological cycle, a fundamental component of climate, is likely to be altered due to change in climatic conditions (Arora *et al.*, 2008). Warmer climatic conditions will accelerate it by altering rainfall pattern, magnitude and timing of run-off; increasing the potential of floods due to intense rainfall and retreating of glaciers (Mall *et al.,* 2006).

Climate change is likely to affect the temporal and spatial variability of extreme events and available water resources (Singh, 2009). Immediate impacts already being felt includes the increased frequency of climate related hazard events such as storms and floods, increased occurrence of drought. However, there is rare statistical evidence for validating the climatic projections and their consequences in terms of disaster events and impacts especially at regional and local scales. A large part of the seasonal anomalies in the monsoon is accounted by the inter-annual variability, decadal and longer term changes manifest themselves as changing frequencies of extreme anomalies (Gupta et al., 2009).

The NW India is vulnerable to extreme weather events like drought, floods, heat and cold waves etc. Over the decade of 1990s, both the frequency and severity of such hazards has increased (Kumar, 2009). These events in the region appear relatively much serious than any other part of the country because more than 80 % of its population is relying on agriculture, directly or indirectly, as the impacts are critical for its food security.

Climate change seems to be the key factor influencing the glacio-hydrological characteristics of the Himalayan glaciers in the recent years (Kulkarni 2001 and Hasnain, 2002). The retreat of glaciers might affect the runoff of the streams originating from these areas (Kulkarni et al., 2002; Bahuguna *et al*., 2004). This might happen for the next 30 to 40 years, but after that the perennial rivers may convert into seasonal streams due to shortage of runoff water from the melting of snow and glaciers. The snow avalanches and glacial lake outburst floods predominate at very high elevations, flash floods in middle elevations and floods in the plains. In these water induced disasters, hundreds of lives and millions of rupees worth of infrastructure and property are lost every year (Joshi, 2006).

Climate change conditions changes the nature of floods, rainfall pattern, flash floods, flood timing, water logging, drought etc and put the question mark on the food and livelihood security of the region. The future climate would be wetter and warmer than the present climate which affects the type, magnitude and the temporal distribution of floods as well as frequency of flood peaks (Loukas et al., 2004).

Adaptation and mitigation strategies

Mitigation refers to anthropogenic interventions to reduce the sources or enhance the sinks of greenhouse gases and 'adaptation' is concerned with addressing the consequences of climate change. Thousands of people, their lives, livelihoods and homes, along with expensive infrastructure are at great risk from hydro-meteorological events in the NW region of India. The threat to communities is likely to increase in the face of climate and environmental change. So there is an urgent need for new and approved mechanisms for strengthening the adaptation and mitigation strategies. Adaptation and mitigation activities require good qualitative understanding on the role of rainfall variability and their likely impacts. To reduce the impact of climate change there can be two approaches: one is mitigation efforts towards controlling climate change and second is adaptation towards the impacts of climate change.

In order to minimise the adverse impacts of climate change and attaining sustainable development, there are needs for developing rational adaptation strategies and enhancing the capacity to adapt these strategies. The adaptation strategies are required to reduce the vulnerability of problems arising by climate change and also increasing the resiliency of communities. Various adaptation strategies suggested for the NW region of India are:

The analysis of factors such as glacier melt, discharge, tectonic events, spatial-temporal variability in precipitation, geology, geomorphology, land use/land cover, population growth, deforestation etc needs to be carried out in order to better understand the 'cause and effect' relationship between climate change and associated hazards propensity.

To establish the short-term and long-term guidelines for the sustainable environmental development of the region as well as their proper implementation.

Preparing environmental impact assessment models and sustainable livelihood framework which help in better understanding of link between climate change and Disaster Risk Reduction (DRR) of hydro-meteorological disasters.

Preparing the inventory of glacial lakes and building reservoirs to control the excessive runoff from the melting of glaciers and incessant rainfall in the hilly region.

Determine the vulnerability of region to climate change and identify associated risks and prioritise adaptation responses accordingly.

Promoting a holistic approach in integrating risk management by combining various hazards, their vulnerability and risk assessment, especially at regional and local levels.

Increasing the capacity building and resiliency of peoples through awareness programmes, active participation of community in preparedness and response efforts and other decentralised community based approach.

Considerable risks to the fragile mountainous areas can be ameliorated by the execution of catchment treatment plans, integrated river basin and water management schemes which

should be cost effective and environmentally efficient.
Consideration of socio-economic and environmental aspects along with Disaster Risk Reduction (DRR) as on priority basis before the start of any developmental activity.
Development of improved gauge stations, early warning and communication system for providing timely information, keeping in mind the present and future scenarios of climate change and their predicted impacts on hydro-meteorological disasters.
There should be 24X7 weather channels which provide timely and accurate information on weather conditions, climate change, natural hazards and other environmental issues.
Preparing the inventory of water induced natural hazards and the area affected with the help of available state of art technologies i.e. remote sensing and GIS.
Establishing co-ordination in gathering, storing, sharing and dissemination of hydrological and meteorological data among concerned states along with regional and trans-boundary cooperation to improve early warning systems.
For the better quantitative assessment of climate change impacts, it is imperative that more accurate ' damages' and ' increasing vulnerability of area' relationship should be established and update periodically.
Local people have much knowledge about local-scale variability in climate and its impacts. Therefore, the traditional/indigenous knowledge and its linkage with scientific information will be useful in dealing the consequences of climate change on hydro-meteorological disasters along with feedback mechanism.
It is necessary to review the developmental policies and land use regulations in the region, keeping in mind the climate change scenarios and its impacts.
Strengthening policies which enable the storage of surplus water during the monsoon, and improving the availability of water during dry season (watershed development, afforestation, infrastructure for water storage and hydro electricity).

Adaptation will have to be supported by mitigating measures that address the root causes of climate change: the emission of greenhouse gases and other substances that cause global warming. No full proof mechanism is there to combat the impacts of climate change, but suitable and necessary management practices can be adopted as mitigation measures. Various mitigation strategies are:

All the countries of world should undertake immediate and rapid action to reduce the emission of greenhouse gases, by ensuring the long-term sustainability of the developmental activities.
Adoption of clean development mechanism (CDM) technologies which are benign towards climate and aid to control the phenomenon of climate change.
The landmark initiatives should be undertaken for sustainable pathways by shifting to environmental benign technologies, which can help in controlling climate change.
Population control measures, investment in enhancing quality of road and rail networks, energy conservation and efficiency programmes, policies for promoting renewable energy, investment in water conservation practices, resource recycling, land restoration, climate friendly infrastructure, afforestation should be enforced effectively.

The impacts of mitigation will be felt in long run by the future generations while the benefits of adaptation measures are immediate. We know that climate change is a global issue but its consequences are felt at regional level. The predicted climatic variability is likely to increase the intensity and frequency of hydro-meteorological hazards. Available strategies may be effective in reducing negative impacts in short term, up to limited extent, but the necessity is to take steps for stronger mitigation measures and increasing adaptive capacity which requires regional adaptation research, capacity building, developmental priorities and accordingly change in policies (Aggarwal, 2009). So, there is need of hour to work at national and regional levels to combat the challenge of climate change and its impacts.

CONCLUSIONS

The conclusive results make it clear that the problem of climate change is real with varied consequences on regional scale. The impact of projected future climate change may be felt more severe, especially on the hydro-meteorological hazards. In spite of the uncertainties about the precise magnitude of climate change and its possible impacts on the NW region of India, mitigation and adaptation measures must be taken to anticipate, prevent or minimise the causes and adverse effects. From time to time, it is necessary to evaluate the efficacy of various strategies or coping mechanism that may reduce vulnerability towards climate change. There is a need to prepare the communities, institutions and governments of the region to anticipate the consequences of climate change and evolve suitable and cost-effective adaptation responses. In addition to enhancing scientific understanding, it is imperative to generate useful information on the basis of which practical interventions can be crafted for strengthening links between policy makers, planners and practitioners.

ACKNOWLEDGEMENT

Authors are thankful to Indian Council of Medical Research (ICMR) and University Grand Commission (UGC), New Delhi for providing financial assistance in the form of research fellowship.

REFERENCES

1.Aggarwal P.K. (2009). Climate change, food security and adaptation strategies, Proceedings of the Sec. In. Dis. Manag. Cong., National Institute of Disaster Management (NIDM), New Delhi, India.
2.Arora M., Singh P., Goel N.K. and Singh R.D. (2008). Climatic variability influences on hydrological responses of a large Himalayan Basin, Wat. Res. Manag., 22, 1461-1475.
3.Bahuguna I.M., Kulkarni A.V. and Nayak S. (2004). Technical note: DEM from IRS-1C PAN stereo coverages over Himalayan glaciated region- accuracy and its utility, Int. J. of Rem. Sen., 25(19), 4029-4041.
4.Dentener F. et al. (2001). Climate change 2001: The scientific basis, IPCC W.G.I. Cambridge University Press,

Cambridge, United Kingdom, 50.
5.Gupta A.K., Nair S.S. and Sehgal V.K. (2009). Hydro-meteorological disasters and climate change: conceptual issues and data needs for integrating adaptation into environment-development framework, J. Ear. Sci. Ind., 2, 117-132.
6.Hasnain S.I. (2002). Himalayan glaciers meltdown: impact on South Asian Rivers. Proceedings of the fourth international FRIENDS conference, International Association of Hydrological Sciences, Cape Town, South Africa, 274, 417-423.
7.Hingane L.S., RupaKumar K. and Ramana Murthy B.V. (1985). Long-term trends of surface air temperature in India, J. of Climat., 5, 521-528.
8.Houghton J., Ding Y., Griggs D., Noguer M., Van Der Linden P., Xiaosu D., Makdell K. and Johnson C. (2001 eds). Climate change 2001: The scientific basis, contribution of working group I to the third assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, 881.
9.IPCC (1990). Report: Climate change- Scientific Assessment. In: Houghten J.T., Jenkins G.J., Ephraums J.J. (Eds.), Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom, 365.
10.IPCC (2001). Climate change 2001: Synthesis Report. In: Watson et al. (Eds.), Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA, 398.
11.IPCC (2007). Summary for Policymakers, climate change 2007: Impacts, adaptations and vulnerability, a report of working group II of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
12.IPCC (2013). Summary for Policymakers, climate change 2013: Impacts, adaptations and vulnerability, a report of working group II of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, UK and New York, USA.
13.Joshi V. (2006). Extreme rainfall events (cloud bursts) and its consequences in the Indian Himalayan Region: needs an in-depth study, Proc. of the First In. Dis. Manag. Cong., National Institute of Disaster Management (NIDM), New Delhi, India.
14.Kulkarni A.V. (2001). Effect of climatic variations on the Himalayan glaciers: a case study of upper Chandra river basin. In: Srinivas M.G. (Ed.), Rem. Sens. Appl., Narosa Publishing House, New Delhi, India, 477-486.
15.Kulkarni A.V., Mathur P., Rathore B.P., Alex S., Thakur N. and Kumar M. (2002). Effects of global warming on snow ablation pattern in the Himalayas, Curr. Sci., 83, 120-123.
16.Kumar K.K. (2009). Climate change and extreme weather events. Proc. of the Sec. In. Dis. Manag. Cong., National Institute of Disaster Management (NIDM), New Delhi, India.
17.Lal M. (2001). Climate change- implications for India's water resources, J. of In. Wat. Reso. Soc., 21(3), 101-119.
18.Lal M. and Singh S.K. (2001). Global warming and monsoon climate, Mausam, 52 (1), 245-262.
19.Loukas A., Vasiliades L. and Dalezios N.R. (2004). Climate change implications on flood response of a mountainous watershed, Wat., Air and Soil Poll., 4, 331-347.
20.Mall R.K., Gupta A., Singh R., Singh R.S. and Rathore L.S. (2006). Water resources and climate change: An Indian perspective, Curr. Sci., 90 (12), 1610-1626.
21.Meehl G.A. (2005). Washington W.M., Collins W.D., Arblaster J.M., Hu A., Buja L.E., Strand W.G. and Teng H., How much more global warming and sea level rise? Science, 307 (5716), 1769-1772.
22.Pant G.B., Borgaonkar H.P., Rupakumar K. (1995). Climate during the past 250 years over the Western Himalayas: A dendroclimatic reconstruction, Memo. Geol. Soc. of Ind., 32, 78-97.
23.Rupakumar K., Krishna Kumar K., and Pant G.B. (1994). Diurnal asymmetry of surface temperature trends over India, Geoph. Res. Lett., 21, 677-680.
24.Singh R.D. (2009). Climate change, its impact on water resources and adaptation strategies. Proc. of the Sec. In. Dis. Manag. Con., National Institute of Disaster Management (NIDM), New Delhi, India.
25.Singh P., Bengtsson L. and Benstsson R. (2003). Relating air temperature to the depletion of snow covered area in a Himalayan basin, Hydro. Jour. (Nor. Hydrol), 34(4), 267-280.
26.UN (2008). International strategy of disaster reduction, Gender perspective: Integrating disaster risk reduction into climate change adaptation, United Nations, Geneva, Switzerland.

Sandeep Kumar
Department of Environment Studies, Panjab University, Chandigarh

Publish Research Article
International Level Multidisciplinary Research Journal For All Subjects

Dear Sir/Mam,

We invite unpublished Research Paper,Summary of Research Project,Theses,Books and Book Review for publication,you will be pleased to know that our journals are

Associated and Indexed,India

- International Scientific Journal Consortium
- OPEN J-GATE

Associated and Indexed,USA

- Google Scholar
- EBSCO
- DOAJ
- Index Copernicus
- Publication Index
- Academic Journal Database
- Contemporary Research Index
- Academic Paper Databse
- Digital Journals Database
- Current Index to Scholarly Journals
- Elite Scientific Journal Archive
- Directory Of Academic Resources
- Scholar Journal Index
- Recent Science Index
- Scientific Resources Database
- Directory Of Research Journal Indexing

Indian Streams Research Journal
258/34 Raviwar Peth Solapur-413005,Maharashtra
Contact-9595359435
E-Mail-ayisrj@yahoo.in/ayisrj2011@gmail.com
Website : www.isrj.net