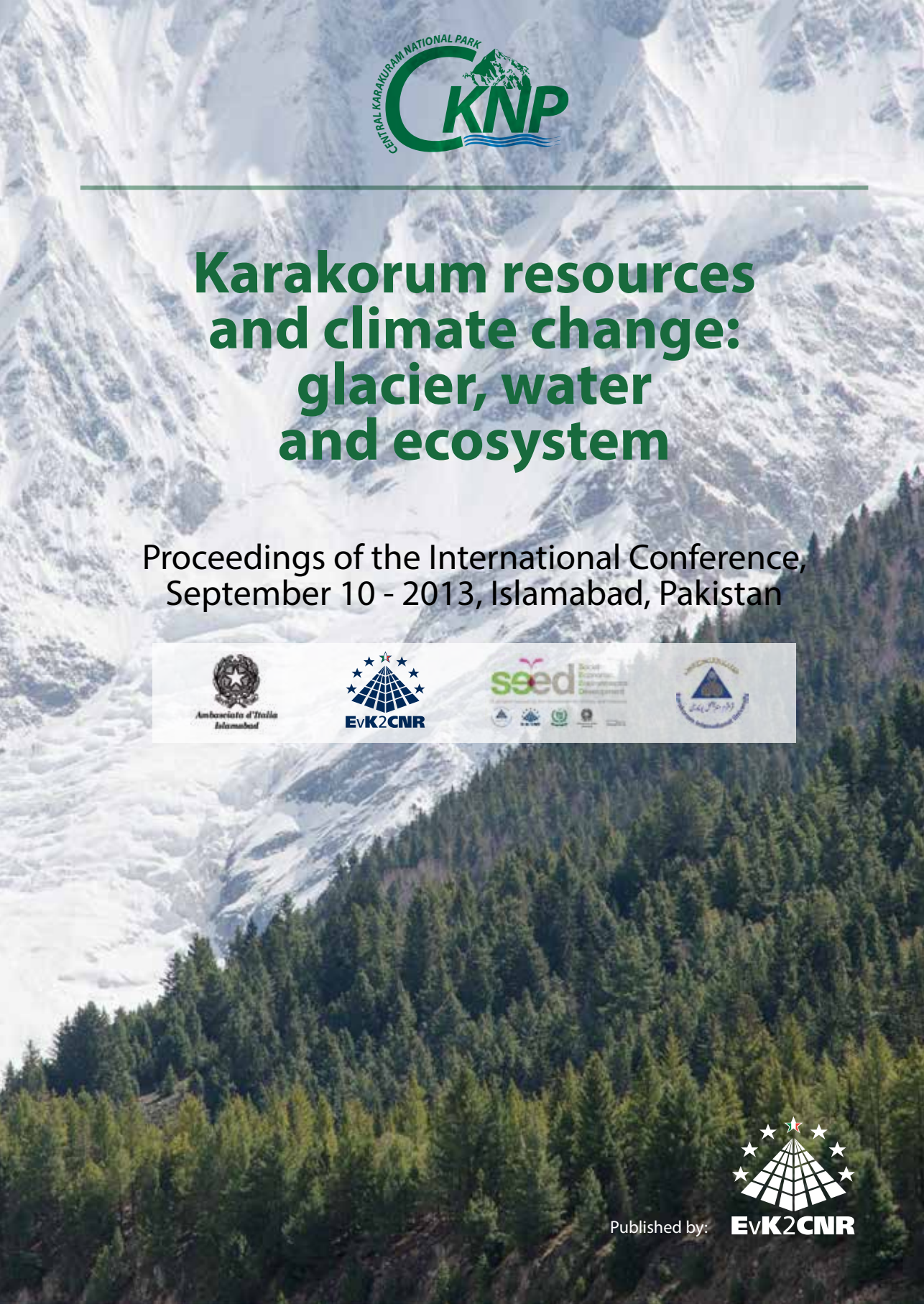

Karakorum resources and climate change: glacier, water and ecosystem

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Karakorum resources and climate change: glacier, water and ecosystem

Proceedings
of the International
Conference

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Foreward

The Hindu Kush – Karakorum – Himalaya (HKKH) range is an extraordinarily high mountain chain, that harbours some of the world's richest environments and most important protected areas. In particular, the Karakorum mountains encompass a wide diversity of flora, fauna and natural resources, such as forests and glaciers.

On the other hand, these high-altitude regions are climatically, geologically and ecologically both sensitive and fragile environments, which can be significantly affected by climate change and modifications in anthropic pressures.

The Scientific Conference on Karakorum Resources and Climate Change: Glacier, Water and Ecosystem aimed to present the state of the art of current knowledge on the Karakorum mountain ecosystem from a scientific point of view, while illustrating mitigation measures to contrast the climate change effects.

All the sessions focused on Karakorum, in particular, on the topics of biosphere, climate change, glacier snow and hydrological cycle in northern Pakistan, extreme precipitation floods and risk assessment and environment impacts, resources management and mitigation actions. National and international high-level speakers took part in the conference.

Preface

The Ev-K2-CNR Association and the Karakoram International University (KIU) has been working closely for many years to promote and develop scientific research in the Karakorum mountains, in an effort to contribute to the development and well-being of local people living in such areas. The two organizations are implementing the SEED (Socio Economic and Environmental Development) project.

The SEED project - financed by the Governments of Italy and Pakistan through the PIDSA (Pakistan Italian Debt for Development Swap Agreement) - aims at an integrated development of the Central Karakorum National Park region through supporting the implementation and management of the Park, developing the Management Plan and improving local well-being and livelihood options.

We decided, together with Dr. Najma Najam - Vice Chancellor of Karakoram International University, to organize a conference devoted to these incredible mountains' resources, but also to the risks they are exposed to due to climate change, in order to focus attention on scientific research and exploration carried out in these areas over the last 100 years.

This is the strongest evidence of an important friendship between these two countries, two Republics of almost the same age, though quite distant from a geographic and cultural point of view: a unique friendship, because of the fact that, since the beginning, Science and Mountains have been "the cement" of this relation, even before diplomatic, economic relations and trade exchanges.

Therefore, I thought that to describe these 100 years of intense relationship, it would be appro-

priate to organize a scientific conference as the heart of a broader initiative that, in many ways, would tell this story with exhibitions, movies festival and events.

It was an event that we decided to call *"The Italian Science and Cooperation in the Shadow of K2"*.

The results of the research carried out, reported during the conference and in this volume by some of the distinguished speakers present, were of great importance for the implementation of the CKNP Management Plan.

The conference was attended by scientists, researchers and representatives of the institutions of Italy and Pakistan, Karakorum-Himalayan region, European Union and other major organizations. Their presence shows that the topic of this volume is of great importance not only to scientists but also of local populations and governments. The focus was on an area which provides vital resources to a significant part of the world's population. In fact, in those valleys and thanks to those glaciers, the Indus River becomes one of the most important water resources of the planet.

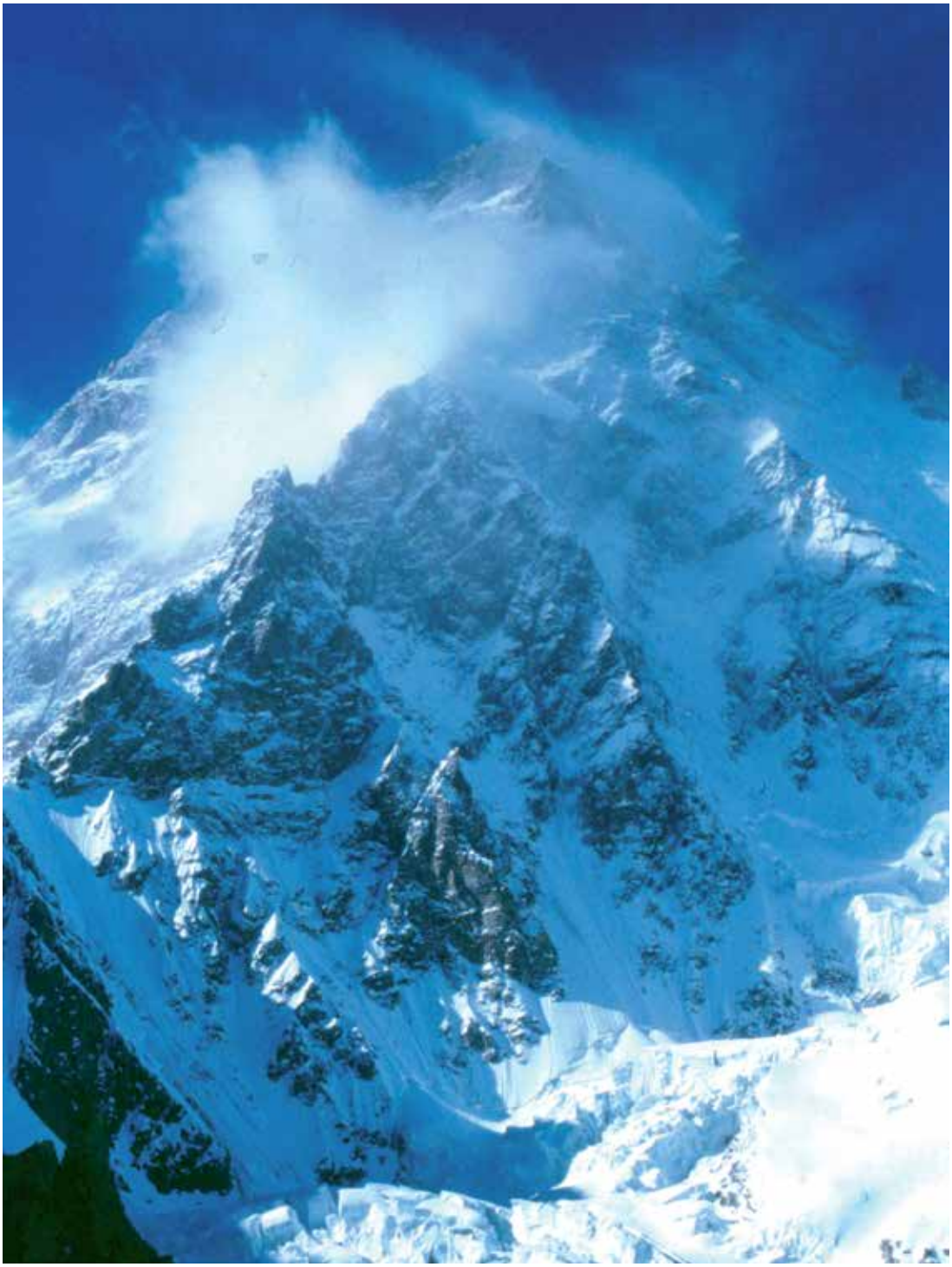
This should be remembered on this occasion too, in order to emphasize the important context in which scientific research on natural resources, the effects of climate change and the activation of possible mitigation and adaptation, must be viewed.

Today, I am glad to say that the Central Karakorum National Park has got its own Management Plan, created by the joint scientific research between Pakistan and Italy.

The CKNP Management Plan was officially approved by the Government of Gilgit Baltistan, definitively establishing the Park's boundaries, areas, and management rules.

This is a further proof of how scientific research, development and protection of the territories and people's welfare could and should move forward together.

Agostino Da Polenza,
President of Ev-K2-CNR Association



Karakorum resources and climate change: glacier, water and ecosystem

Opening Remarks

Mr. Himayatullah Khan
Special Secretary to the President of Pakistan

I am thankful to the organizers for inviting me to the inaugural session of the Scientific Conference on **"Karakorum Resources and Climate Change: Glacier, water and ecosystem".** I am rather impressed by the theme of the conference which is of tremendous importance for Pakistan, its government and people. Although not a specialist on the subject, I understand that I shall be affected if anything goes wrong with important components of the environment, such as these.

Karakorum mountain range is not only a source of life but also a source of pride for us and I personally feel delighted to see that its issues and problems shall be addressed and discussed by a conference of this level.

In the presence of relevant ministries and departments, professionals, as well as provincial authorities, I may not feel justified to say anything on the technical aspects of the conference, but since they are of concern to every citizen of Pakistan and a priority of our political governments, I will certainly feel happy and enthusiastic if the Karakorum mountain range is saved, with effective efforts to keep its natural resources intact.

Presumably, this is something that the conference will be doing.

I am particularly keen to express our gratitude to EvK2CNR, an Italian NGO, that has not only been working on the management plan of Central Karakorum National Park along with the Government of Gilgit-Baltistan, but has organized this conference for the general aware-

ness of everyone and for sharing the successes and lessons achieved so far.

While looking at the programme for today, I noticed a session on Biosphere Reserve that shall soon be starting after the brief inaugural session. I further know that most of the Karakorum Range is being considered to be designated as a Biosphere Reserve under the UNESCO's Man and Biosphere Programme. Being the Focal Ministry, I congratulate the Ministry of Science and Technology, and in particular, the Pakistan Science Foundation, to have initiated the process to undertake the task. The relevant department of Gilgit-Baltistan is also being appreciated for undertaking the responsibility for it to be managed as a Biosphere Reserve. As a citizen of Pakistan, and in my capacity as staff of the President House, I see it as a commendable job and hope that the Karakorum Biosphere Reserve shall soon be on the World network of Biosphere Reserves. Obviously, this shall not only be helpful to save our precious Biodiversity but will help the local communities as well.

I wish every success for the conference and hope that it proves useful not only for participants who are sitting around and attending the conference but also for people sitting far off from Islamabad, through the media.

This will really be great if our people are helped to understand the conservation philosophy behind a conference like this.

May I also suggest that, since we have similar problems in the Hindukush and Himalayan mountain ranges that are equally important not only for hundreds of thousands of people living there, but also millions of others that live downstream, Ev-K2CNR may see the possibility of helping it. They may include it in their future plans, if it is not possible for them to take it up immediately.

In the end, I must thank our Italian friends, a group of professional scientists, for helping us in the conservation of our precious resources. I do hope that their efforts shall not only bear fruit in the form of better scientific management of our precious natural ecosystems, but may equally help to strengthen ties between Italy and Pakistan, who are friendly countries and are cooperating already in various different fields with each other.

Ladies and gentlemen, I do wish to be with you the whole day, getting myself enlightened on issues such as these, but since I have to rush back to the Presidency, I will miss the session on Biosphere Reserve and others that follow. However, I will keep myself informed of the results and conclusions and will try to be of some support from behind the scene.

Prof. Najma Najam

Vice Chancellor of Karakoram International University

Ladies and gentlemen, I thank you for giving me this opportunity to speak at the inauguration ceremony, and it is certainly an honor to be here at the meeting of collaborating scientists of EvK2CNR, KIU and partners.

Excellencies, Secretary to the President of Pakistan, Ambassador of Italy to Pakistan and other luminaries who are part of this present gathering, I would like to present KIU's role and work as a partner of SEED project, as I would not be getting an opportunity to talk about what we do at KIU. We are the major partner of EvK2CNR in running this project.

It's a huge and complex project, perhaps not even envisioned by those who planned it in initial stages.

We who are implementing it, have realized that the impact of this project will not just contribute to scientific research or the communities, but will also affect the whole range of life and living within the Karakorum and the Central Karakorum National Park.

I will just give you a brief introduction to the work we are doing and the colleagues and scientists who have been spearheading projects.

Ladies and gentlemen, let me state at the very beginning, this is a model to be followed and perhaps other Pakistani universities may do so in future.

Many Italian scientists and a consortium of seven Italian universities is working with us, i.e. with KIU university, and we have been successful in running multiple projects.

As most of the audience already knows this, I

will not be talking about this in detail. Suffice it to state that SEED was a joint initiative under the Pakistan Italian debt for Development Swap Agreement and was approved and signed by the Economic Affairs Division of GOP and Embassy of Italy in August, 2009. We, the EvK2CNR and KIU, are not just partners but also members of the Steering Association which spearheads the project, and we are also members of the Scientific Association which coordinates and monitors research and other related projects. In addition to scientific research, we envisioned training and human resource development for KIU and the region.

Under these programmes multiple activities were planned e.g. safe mining, fruit farming, and gem stone cutting, and carpentry, which aim to benefit the communities directly. We also have a huge project which supports the KIU PHD students. The first ever PHD programme at KIU, involving a joint supervision and joint research of KIU and Italian universities, is our flagship programme and is on-going.

There are multiple collaborative research projects, as well as about forty independent research projects, which are being carried out right now by faculty members.

I always say that when I look for my faculty on the weekends they are up in the mountains, young and old, they pack up and leave, as they are collecting data, and this is important for the data base we will develop eventually at the IMARC. EvK2CNR and the SEED project have also funded a laboratory, which is the state-of-the-art laboratory in GB for water quality assessment. We have also been supported for photovoltaic panels for continuous energy generation, for a computer lab, and of course much needed clean water for KIU.

Ladies and gentlemen, just to give you idea of how KIU looks, nestling in the mountains, located in the middle of the mountains.

This is our university, and of course our Italian counterparts have discovered it, they visit and work at KIU. One of early contributions of EvK2CNR has been establishment of the gem stones cutting and polishing labs and the training of young men and women in Italy.

They are working in KIU on various training workshops funded by EvK2CNR. Presently, there are about nineteen PHD students, who are working on their research projects for their PHDs, all of which are related to the mountains, and are important for GB, and certainly, as Secretary to President has said, important for the country as well, and may I say important for the world too.

These PHD students are being supervised by well-known national and international supervisors.

As you can see, and as I was saying, there are seven different Italian universities working with us.

Our PHD students have gone on field missions, both within the country and in Italy (and Slovenia, and from the picture presented you can see they are active in the field). The picture that is seen in the transparencies is the building which we call IMARC, a newly established, Integrated Mountain Area Research Center, which is going

to be hub for all research done in the mountains. This was envisioned when the project started, and inaugurated last year. The field researches carried out by KIU faculty are very much in line with the need of regions, and skills development training conducted by faculty members includes safe mining projects (as most of the precious stones mined by the local miners are obtained by blasting through the mountains, resulting in a loss of about 90% of stones).

Our faculty members from the Earth Sciences programme and Ev-K2- CNR scientists have trained miners on safe mining techniques, also helping them to recognize that there are toxic substances within the mountains which can damage them forever.

Of course, traditional carpentry is again a project of human resource development and conservation of traditional techniques, which have been conducted successfully, and a show room established. Further, training of farmers is interesting - as when these workshops were planned, we never thought we were going to have women interested in farming.

There are women who are working as farmers, but this is the project which caught the attention of these young women who work in the field of fruits, and volunteered themselves to attend.

Thus we trained them and they are now implementing this training in the field.

They were trained in seed selection, pest control, use of fertilizers, as well as fruit preservation, and you can see in the pictures, these are young female farmers.

As for the research projects I referred to earlier, there are twenty plus ongoing research projects, for about forty million rupees, and all faculties and departments of KIU are involved in a large number of varied issues, specifically for the CKNP region.

The data base, as I said earlier, will be formed for reference and for future studies, and data range from hydrology, water quality, quality of life, eco-tourism, medicinal plants, flora, fauna, and even livestock. I would just show some of the on-going projects.

The first one is on the Barbarea fruit, and the nutroceutical component and anti-microbial components of this are being assessed by the chemistry, agriculture/food and biology department researchers.

The second project is also very interesting, looking at the floral diversity of Haramosh valley, and the third project (which will be elaborated later by the researchers) is on the threatened birds of the region.

So when we talk about hydrology, glaciology, and water management, and we also have a wide range of other issues associated with them, which our researchers are working on.

So ladies and gentlemen in summing up, this is a highly complex, but very successful project. It is one hugely successful story as I was telling his Excellency the Italian Ambassador. There are very good things happening in Pakistani universities, and certainly excellent work is being carried on in remote mountains. We have not

been talking about it, but it is there, but more than that we shall have success stories in the long term relationship of the two countries, and of the university students of two countries. The Italian universities research organizations and Pakistani universities with KIU.

In short, EvK2CNR and KIU are bringing the mountains and peoples of Pakistan and Italy together.

Mr. Khadim Hussain Saleem
Secretary Forests Gilgit Baltistan Government

Excellencies, ladies and gentlemen, luminaries from Pakistan and Italy, and my friends of GB and particularly from Pakistan.

Thank you very much for organizing this wonderful, an educative and informative scientific conference. I think this the right time that we should go for heavy and hard concrete scientific research, because until, and unless we have basic data about the problems, we cannot be able to understand them, and we cannot be able to make policies and strategies about the problems we are facing.

Ladies and gentlemen I would like to express my gratitude and thanks to the GOI, and EvK2CNR for the work it has been doing in Pakistan, but particularly in GB.

GB is a very remote area, and it is out of the general perspective and not only out of sight of the world, but of our neighbours in Pakistan also. We are extremely thankful to EvK2CNR, and to the Italian Government, in that they are doing lot of hard work in GB, particularly in Karakorum areas. When I see the amount of energy, commitment, dedication that the organization is putting into GB, I see a kind of emotional attachment between the two organizations, and the two countries, and there I see a kind of work coming out from their hearts.

That is what appeals me, and I hope this will not only help the people in the mountains, but also help in making the environment better.

The changes coming in the environment will be

able to affect in a positive way not only Pakistan, but also the world at large, because as you know the environment of GB is extremely unique and special, with a concentration of the highest peaks and glaciers, water reservoirs and courses from GB, and I think a small positive change will positively affect the people of this region and the negatives changes will also affect the area accordingly.

I would like to express a few things about the conference and GB, and the problems that we are facing. GB, as we know, is inhabited by a small population, although the area is very large, about 74,496 sq.km., but the population is 1.2 million, with a growth rate of 2.47% per annum. The growth rate is very high in the remote valleys.

The population density is about 15 people per sq. km.. Compared to the larger problems of climate changes and environment degradation, it seems small, but the effect is larger.

Ladies and gentlemen, climatic variability and extreme weather conditions are from 40 degrees to -40 degrees, which puts pressure on the forest and natural resources, and the survival of people in extreme conditions.

Mostly the population of GB is concentrated in major urban areas, but there are 800 small villages inhabited by people. Pakistan's contribution to greenhouse emissions is very low, and lower in GB. However, the phenomenon is affecting the region.

The local triggering factors are: deforestation and forest degradation; use of fuel wood in winter for heating and cooking, and subsequent carbon emissions; carbon dioxide emissions due to the burning of municipal solid waste as no mechanical disposable is available.

Lands are used to promote change in urban areas, and tree-cover is decreasing due to the expansion of settlers.

Apart from the global climate change phenomenon, among the local triggering factors are burning fuel woods and solid waste. Urban centers in GB have grown without proper land use planning and zoning, and new exotic materials, like cement and concrete, have been used instead of indigenous materials.

These have all contributed to climate changing phenomenon and global warming. Solid waste has been the problem in urban centers, according to a regional survey conducted by the GB environmental protection agency, and five hundred kg per capita is being generated.

Seasonal fluctuations are also recorded in summer and winter, due to the absence of municipal solid waste collection and land-fills using tractors.

Therefore, half of the waste the communities are burning, while half of it lies in the vacant places, where it is never moved. In many areas in GB, varied peoples are dependent upon the seasonal stroke over. Due to lack of glaciers, and it can be well observed in the urbanized areas.

The mountains of those areas are strongly dependent on the snow they receive and the subsequent melt in summer as the temperature increases.

However, in the last decade it has been observed that the season changes from early winter to late winter, and rapid changes in temperature, make snow melt and subsequent flooding increases downstream, and some of the permafrost in the proximity of these areas has now vanished away.

Ladies and gentlemen these are the few problems I have addressed regarding GB.

I hope that the municipal authorities come with measures and strategies for addressing the issues I have pointed out and will help us amend such policies.

This will be helpful in adopting the steps that we will be employing.

I wish good luck to the conference.

Mr. Berend De Groot
Head of Cooperation, EU Delegation to Pakistan

Mrs. Vice chancellor of KIU, colleagues of EvK2CNR, Mr. Ambassador, ladies and gentlemen, it's a great pleasure to address the conference this morning.

Understanding climate change and its impact, and working on mitigating the effects of rising temperatures and change in weather patterns are high on the EU agenda.

There is a strong recognition of the potential implications of increasing pressure on the environment and on natural resources, especially water. This is a global issue, and the EU, on behalf of its 28 Member States, is playing a lead role in global negotiations on climate. In a few days, the European Union will be hosting in Brussels the meeting of the Global Climate Change Alliance, set up in 2007 with the aim of strengthening dialogue and cooperation on climate change with developing countries most vulnerable to climate change.

This event will aim at validating and spreading knowledge and we expect it will drive the 35 countries involved to increase the climate focus of their national development strategies.

Many reports, papers, etc. have been produced concerning climate change related measures, reduction of emissions and of deforestation, climate information and the national monitoring system in Pakistan.

These points are all very relevant. National strategies are even more important, in as much as they look at how it is possible to fully integrate into the public finance management, into the budgeting, all these crucial aspects.

Let me come back to the ground of our relation with Pakistan.

Climate change in Pakistan is an important concern for the EU, which adds to the burdens of a rapidly increasing population and of a not-fast-enough economic development.

We have been examining the sector more closely since 2011 and we are aware of the importance of being involved in climate change related problems and in helping to adjust the national development agenda.

We are not the first ones, quite a number of organizations are working on these issues, with quite a lot of ideas put forward.

Quite a lot of conferences, quite a lot of workshops have taken place, and all this joint effort is very important.

In concrete terms, our cooperation so far has paid much attention to renewable energy, predominantly through investments in hydro power, at community level.

We initiated in 2011 a 40 million Euro programme in the Malakand division, which supports - among other things - investment in micro-hydels at village level. We are talking here of an equivalent of 20 mega-watts, being made available to villages that probably for decades to come will not benefit from being linked to the main power grid. Besides that, we are looking into investments on small or medium sized structures.

A great deal of talk has gone on about Diamer-Bhasha Dam, and a couple of other mega-projects, but smaller and medium size dams, in the range of 50, 100, 200 mega, are equally important, especially in the short term.

An important aspect to emphasize here is also the relevance of good research.

We subscribe to the 50 recommendations of the Water Sector Tasks Force, which as many of you may remember, was set-up two years ago to provide up-to-date and reliable data and support a consistent, strategic approach.

Now we are sponsoring two sub-initiatives: one is looking into the broader aspects of the ecological and socio-economic aspects of climate change in the area of Karachi, and the second aims to analyse the climate change impact in Swat, in view of hydro-power investments (first and foremost the Munda/Mohmand dam).

It is itself, of course, very strange that a mountainous area like Malakand division depends today upon import of electricity, whereas abundant water flows down on a daily basis.

We hope to be able to share with you the knowledge that has been gathered in the last one and a half year.

When I listen to the words of Madame Vice-Chancellor, this is the sort of engagement and enthusiasm required and which clearly also directs the work done in the KIU university, which is going to build the capacity to do a great job. Research, especially on hydrological aspects, on better understanding precipitation and weather elements, is extremely important.

We explored two years ago - with limited success - the possibility to support this type of research, challenging ourselves in the search for funding to stimulate exactly what you heard before.

It is important to note that also among Pakistani institutions climate change calls for proper research, and the promotion of better networking.

Yet, this has proven to be difficult, because of what I would call institutional rivalries, and finding true countrywide shared initiatives remained challenging.

Some ideas might, for example, still dwell within the Indus Basin programme, or the Indus initiative that was launched by ICIMOD a few years ago. The idea was put forth by the Water Sector Task Force and yet has to demonstrate traction.

This morning I heard from you positive news.

I think there is a dilemma, because the research community would say you have to come with funding and we would say you have to come with ideas that have traction and avoid too many risks of institutionalized rivalries, etc.

There is a dire need to improve knowledge across Northern Pakistan, as Mr. Secretary just mentioned. A much greater density of weather observation stations is, for instance, very necessary.

Substantial work is required to look for more efficient ways of water utilization, starting from the sources, moving to irrigation, and going all around the hills.

Climate change problems in Pakistan are primarily focused on water, water and water, and to understand it you have to start from the very high peaks and go all the way down into the mangroves along the coast.

It is also necessary to look into what disaster reduction means, what the impacts are, and quite a lot of work has to be done.

To conclude, I express my gratitude and appreciations to the organization EvK2CNR for its work and the organization of this event.

I look forward to the outcome of today's debate and wish you a good conference.

Conference Sessions

Potential Sites for the Creation of Biosphere Reserves in Pakistan

1 - Introduction to the session

*(**A. A. Khan**, Ev-K2-CNR – Pakistan)*

The present session concerning biosphere reserves will try to assess a number of issues, and to answer a number of questions, including

- What is a protected area?
- Why is there the need for protected areas?
- What is a Biosphere Reserve?
- Why is a session on Biosphere Reserves needed?

Protected areas are locations which receive attention because of their recognized natural, ecological and/or cultural values. The processes of degradation, especially in countries very sensitive to natural solicitations, including climate change, like Pakistan, may be too fast for the natural ecosystems to sustain them, while maintaining their characteristics. Given the situation of poverty in Pakistan, a country still largely dependent upon natural resources, it is hard to evaluate, minimize, and control anthropogenic pressures upon such resources, without the support and cooperation of the local custodian communities.

In turn, support and cooperation from the local population and authorities remains largely general, whenever a request for such support is not associated with any economic incentives, which will be more effective when linked to the community pledges for the protection of their life support systems, i.e. the natural ecosystems. Generally speaking, it is indeed beyond the capacities of developing countries to address the issues of all natural ecosystems, especially when

the addressing of such issues collides with economic needs for development. Thus, a choice concerning which part(s) of a given environment should be given adequate protection is often necessary.

The sites that are deemed as ecologically important under some rationale can be set aside from widespread deterioration. These are the so-called protected areas.

They may cover any of several recognized categories, including, but not limited to national parks, Wildlife Sanctuaries, etc.

One of such category is the Biosphere Reserve. Only two Biosphere Reserves are present in Pakistan so far, and they will be introduced within the next sections. Biosphere reserves are sites established by countries, and recognized under UNESCO's Man and Biosphere Programme, to promote sustainable development based upon the effort of local communities, and upon sound science. While other categories of protected areas are somewhat known, Biosphere Reserves (BRs) are less clear in their nature so far, and the raising of awareness concerning such reserves is urgently needed.

An effective network of BRs seems very beneficial for the protection of biodiversity, the development of local communities, and the generation of knowledge, given that they provide a flexible approach to management, and they are expected to cover larger areas than other types of protected areas. Indeed, there may be several potential sites suitable to be designated as BRs within Pakistan, but these are known only to a few professionals, and in the past insufficient effort has been made to start the designation process there. The proceedings of the session shall therefore be sharing information on the processes that are involved in the designation of BRs. Such information is useful for all provinces in Pakistan so that they can know and use their landscape, while considering the comparative validity of various ways to protect their natural ecosystems. Local authorities dealing with natural resources management may find it useful to have an extensive network of BRs. There are indeed some examples of BRs, or potential sites to be considered for the establishment of BRs, which will be commented in the proceedings of the session. This session could therefore inspire other Field Officers to take up the process now, even if it was ignored for some reason(s) in the past. We expect from this session information on *I*) the processes and procedures involved in the creation of Biosphere Reserves, *II*) the newly created Biosphere Reserve of Balochistan, *III*) and the potential sites in Pakistan that could be designated as Biosphere Reserves under the UNESCO's Man and Biosphere Programme.

2 - Potential biosphere reserves in Gilgit Baltistan

*(***W. Noor** *Forest Department Gilgit-Baltistan-Pakistan)*

Gilgit Baltistan (GB) covers a rather large area (>70 thousands km^2) in the north-western areas of Pakistan (see Table 1), hosting ca. 1.5 million inhabitants, whose livelihood is mostly based on agriculture and livestock farming. A share of protected areas is present within GB (covering ca. 34 thousands km^2), but no Biosphere Reserves are present. Though there is no Biosphere Reserve in GB at the moment, it was possible to identify 3 potential sites that may deserve to be designated as Biosphere Reserves.

Table 1*. Summary of Gilgit Baltistan main features*

Total Area [km^2]	72496
Population [Inhab]	1.5 M
Land uses:	
Agriculture [%]	2%
Forests [%]	9.4%
Rangelands [%]	22%
Mountains [%]	36.4%
Glaciers [%]	24%
Total protected areas [km^2]	33999
Percentage protected areas [%]	47%
National parks [km^2, number]	[2160, 5]
Game sanctuaries [km^2, number]	[583, 2]
Game reserves [km^2, number]	[2001, 6]
CMA/CCHA [km^2, number]	[9810,27]

The three potential sites are:

1)Karakorum Biosphere Reserve (2 NP: 26000).
2)Whispering Himalayan Biosphere (1 NP: 9550).
3)Hindu Kush Biosphere Reserve (2 NP: 5600).

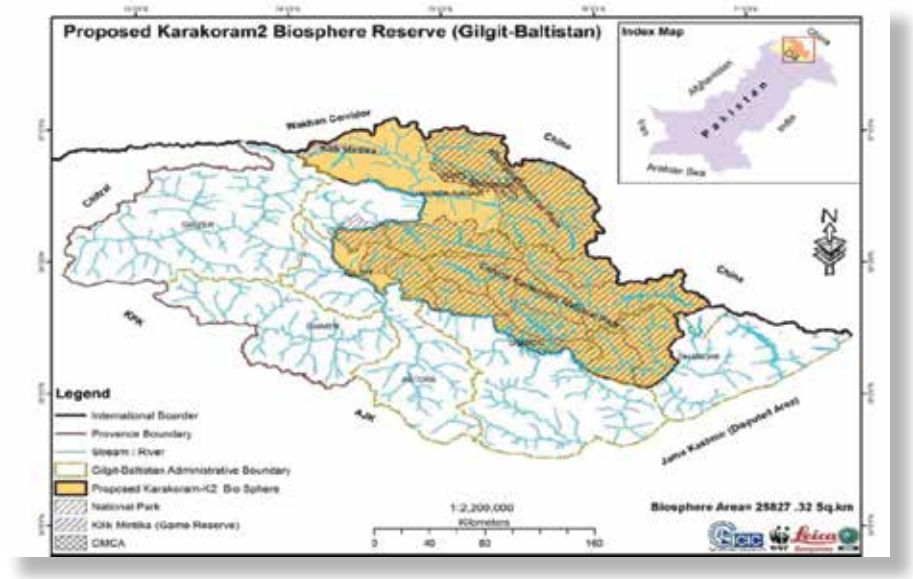


Fig. 1. Karakorum Biosphere Reserve (2 NP: 26000).

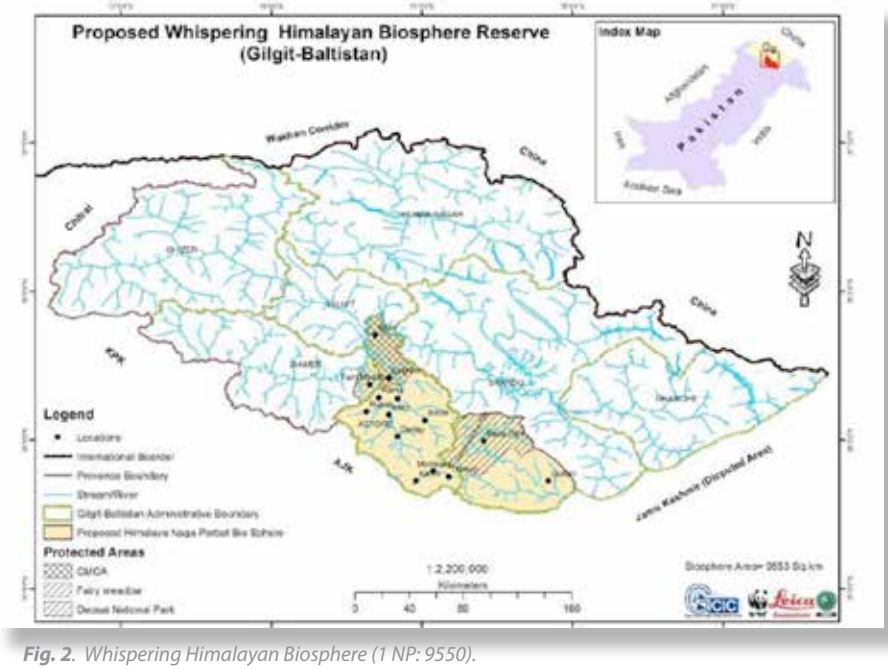


Fig. 2. Whispering Himalayan Biosphere (1 NP: 9550).

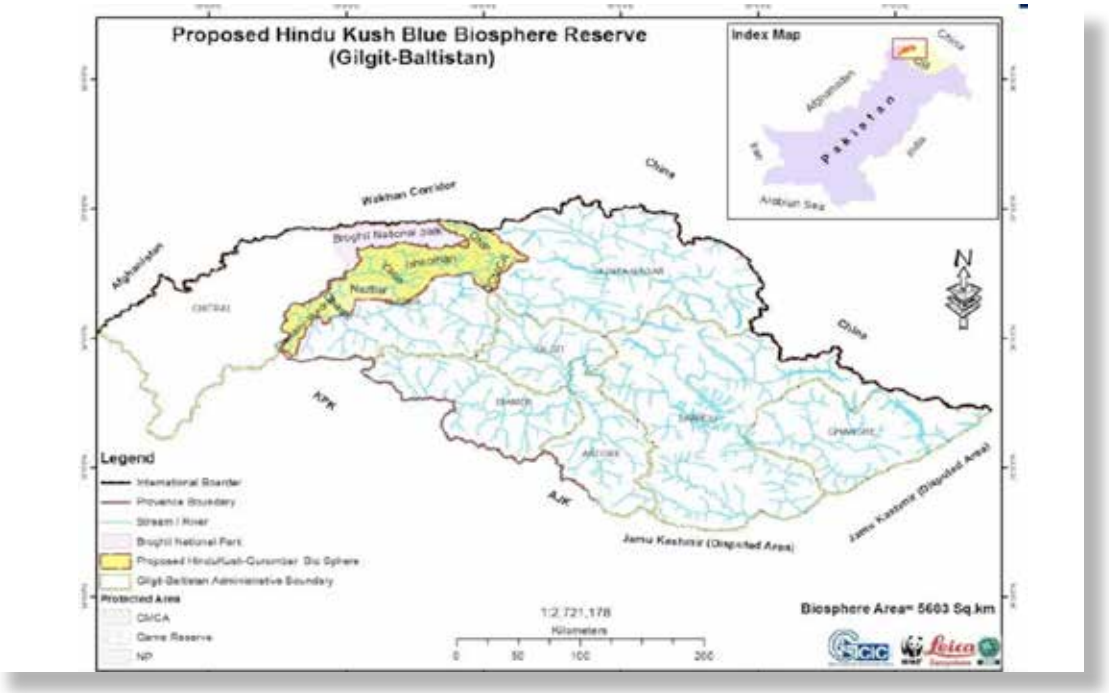


Fig. 3. Hindu Kush Biosphere Reserve (2 NP: 5600).

The Government of GB has so far nominated the three sites above to MoS & T for needful designation under UNESCO's Man and Biosphere Reserve Programme. The nomination Association in its meeting on 26 August endorsed all the proposed sites, starting with the Karakorum Biosphere Reserve with immediate effect. Work has started on the formulation of a dossier for the full proposal.

3 - Ziarat juniper forest ecosystem: a potential candidate for the Man and Biosphere Reserve Programme

*(**S.G. Muhammad** Forest Department Government of Balochistan-Pakistan).*

The Ziarat Juniper ecosystem is presented here as a potential candidate for the establishment of a Man and Biosphere Reserve Programme. We provide here an introduction to the environment and landscape of the Ziarat juniper forest ecosystem, including local population and their livelihoods. Biodiversity within the Ziarat juniper forest will be addressed, and its legal status commented.

In addition, an illustration of the ecosystem services within the Ziarat forest will be given. Threats and implications pending upon the juniper forest will be commented, and the potential for a Man and Biosphere Reserve programme there will be illustrated.

The Ziarat juniper ecosystems covers an area of ca. 67 km^2 within north-eastern Pakistan, situated in a dry-temperate climatic zone. Elevation ranges from ca. 1500 m asl. to ca. 4000 masl. Annual rainfall ranges from 8"to 15" (ca. 200-400 mm).

The juniper tree belongs to Cuppresse specied, in Gymnsperms, and 54-62 species of Junipers have been classified worldwide.

Areas covered include North America, Europe, North Africa, West Asia, South Asia, Central

Asia. Six species of Junipers are found in Pakistan, one of which *is Juniperus Excelsa Polycarpos. Balochistan* has one of the largest remaining tracts of pure *Juniperus macropoda*, or *Juniperus excelsa polycarpos*. Locally, the Juniper is known as Obusht in Pashto, Hapurse in Brahvi and Majoo or Sanober in Urdu, and it is a medium sized tree attaining a maximum height of 80' (ca. 2 m), with an average crop height of 50' (or 1.25. ca.) The Juniper is often viewed as a "living Fossil" because of its longevity and slow growth rate.

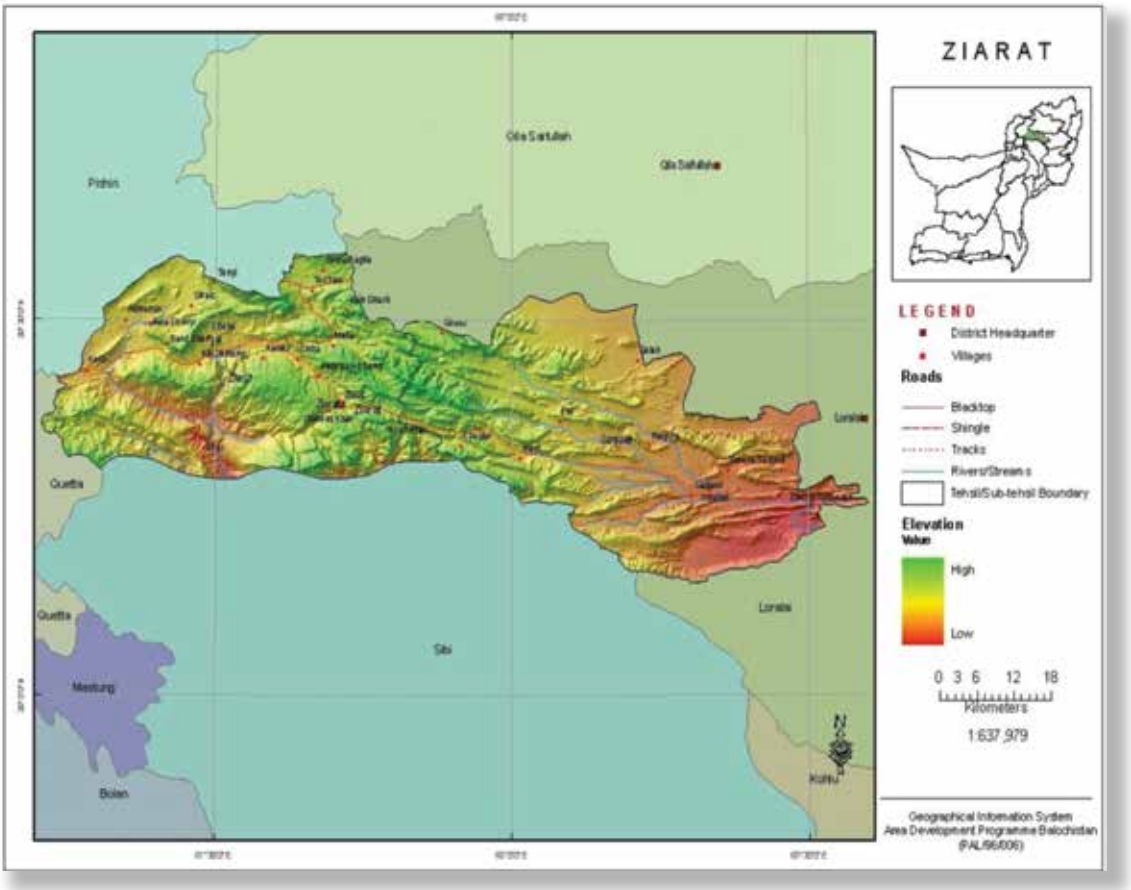


***Fig. 4**. Ziarat Juniper Ecosystem, in Northern Pakistan.*

Major tribes present within the Juniper forest ecosystem are:

1) Kakar (Sarngzai, Panezai, Dummar, Yasenzai, Sanzerkhail, Sanarzai)
2) Tareen (Venachi, Raisani)
3) Sayed (Taran, Pechi)
4) Ghilzai (Dotani)

The main livelihood sources are agriculture (mainly horticulture), livestock rearing, tourism (hotels, shops, transportation, etc.), business (retailers, shopkeepers, contractors, etc.), services, and mining. Biodiversity in the juniper forest ecosystem displays an array of plant species, including Wild Ash, Wild Pistachio, Wild Almond, Wild Olive, Makhai, Zralag, and some of the associated plants of Junipers are of a high medicinal value, like Ephedra spp.

The Juniper forests provide refuge to wild mammals, like the Suleiman Markhor, Wolf, Fox, and birds, like Chakur and See See partridge.

Legally the Juniper forests of Ziarat and the allied biodiversity enjoy the status of State Forests under the Balochistan Forest Regulation, 1980.

Table 2. *Fauna and flora biodiversity in the Ziarat Juniper forest.*

Zone	Descr. Flora
Higher hills	Juniperus Excelsa Polycarpos predominant, Pistacia Khinjjak, Ephedra Nebrodensis, Ephedra Intermedia, Fraxinus xanthoxyloides
Foot hills	Mostly fertile soils areas, Summer grazing for local and nomadic species. Various shrubs present, e.g. Artemisia meritima (Tharkha), Prunus Ebernea (Wild Almond), Caragana Ambigua (Makhi), Berberis Lycium (Zralg), and Sophora Grifithii (Ghuzaira). Lower hills host Zaitoon (Olea Ferruginea), and Mazri (Nannorrhops Ritchieana).
Piedmont/valleys	Mostly modified for agriculture and other land uses. Mostly seen Artemisia meritima (Tharkha), Haloxylon Grifithii, and sporadic seasonal forage plants, supporting large grazers' community.
Dry stream beds	Commonly seen Tamarix Spp.

	Descr. Fauna
Mammals	Straight-horned Markhor (Capra falconeri megaceros), Wolf (Canis lupus), Hill fox (Vulpes vulpes grifithi), Asiatic Jackal (Canis aureus), Cape hare (Lepus capensins), Porcupine (Hystrix indica), Afghan Hedgehog (Hemiechinus auritus), Afghan Pica (Ochotona rufescens), and Stone Marten (Martes Foina)
Birds	Chukar (Alectoris chukar), See see partridge (Ammoperdix griseogularis), Kestrel (Falco tinnunculus), Rosy Starling (Sturnus roseus), Magpie (Pica pica), Golden eagle (Aquila chrysaetos daphanea), a number of sparrows, finches, season/migratory waterfowls, hawks, bustards, and sand grouse, etc..
Reptiles	Afghan Tortoise (Agrionemys horsfieldii), Agama (laudakia caucasia), Brown Cobra (Naja Oxiana), Saw-scale viper (Echis carinatus), Dwarf Dark headed racer (Ereni persica walterii), Levantine viper (Macrovipera lebetina), etc..

The ecosystem function of Juniper forests are several, including

- ➤ Sustain the local demand for fuel wood
- ➤ Deliver timber for construction of hutments and hedges
- ➤ Protect watersheds and enhance groundwater recharge
- ➤ Increase soil fertility through humus addition
- ➤ Provide rangelands for livestock production
- ➤ Provide a habitat to a variety of wildlife etc.
- ➤ Help in maintenance of environmental balancethrough micro-climatic effect
- ➤ Sustain ecotourism - one of the main livelihood sources of the local population
- ➤ Provide medicinal plants

As a result of the increase in human and livestock populations over the years, and frequent occurrence of natural disasters, the Juniper forest ecosystem of Ziarat is facing several threats, including natural and anthropogenic risks. Natural threats include droughts, insect and pest attack, mistletoe infestation, absence of/low regeneration, soil erosion and low water holding capacity, natural die-back and very slow growth rate. Anthropogenic threats include demand for energy/fuel wood, demand for timber, land use change, agriculture, extension of town, road construction, livestock, mining activities, forest fires, stripping off barks for roof thatching, and tourism. Loss of habitat may result in the loss of species richness, which would ultimately lead to a loss of Biodiversity in the ecosystem. A reduction in agricultural production, livestock breeding and other goods and services, such as water, medicinal plants and tourism, would definitely affect the livelihoods of resident communities. The Ziarat forest displays a large potential for an MAB program. It includes vast stretches of pure strains of *Juniperus excelsa polycarpos*, with old trees of 1,500 or more years in age. A rich floral and faunal biodiversity is observed in the forest. Cooperative and to some extent organized communities are present therein. The Man and Biosphere Reserve thus presents ones of the best options for restoration as well as improvement of the Juniper forest ecosystem.

4 - Potential Sites for the creation of Biosphere Reserves in Khyber Pakhtunkhwa

(**M. Farooque** - *KP Wildlife Department, Peshawar-Pakistan*)

In Khyber Pakhtunkhwa various government departments are addressing the issues concerning nature and natural resources. The Khyber Pakhtunkhwa Wildlife Department serves as technical and focal department of the Government for the matters related to wildlife and biodiversity of the Province. In a Biosphere Reserve, the focus of management is at the landscape level. According to international commitments under various Multilateral Environmental Agreements, the department also promotes an ecosystem level of conservation to conserve biodiversity of various landscapes. Thus the functions of the Biosphere Reserve and Wildlife Department are identical. Consequently, the requirement of Biosphere Reserve management is the mandate of Khyber Pakhtunkhwa Wildlife Department.

Within this contribution some aspects will be addressed, namely:

- ➤ Legal aspects of protected areas per categories,
- ➤ Candidate sites, and
- ➤ Key questions, such as why should an area be declared a Bio-reserve?

According to the Khyber Pakhtunkhwa Wildlife (Protection, Preservation, Conservation and Management) Act 1975, there is no provision for declaring an area as "Biosphere Reserve". The existing law has a provision for declaring the categories of protected areas within the province as in Figure 5.

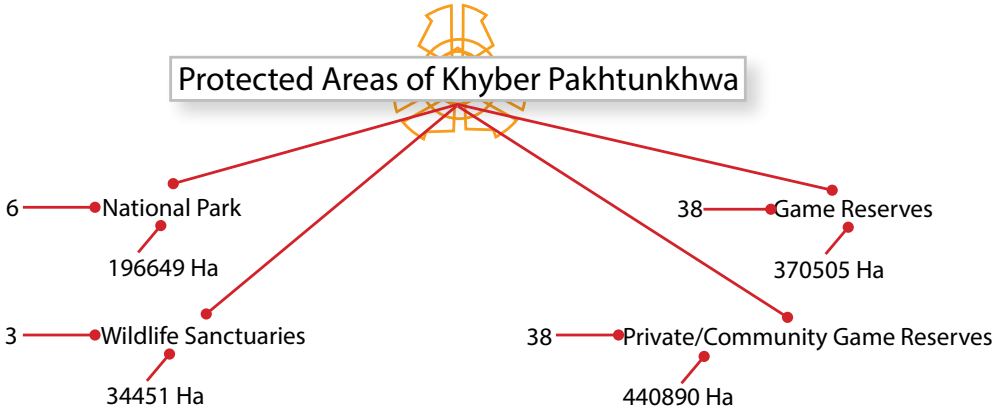


Fig. 5. Number and area of different categories of protected areas.

Both at the local and global level, several transformations have recently occurred in Environmental Governance, including:

- ➤ Paradigm shift in environmental governance, from traditional top down management strategy to co-management
- ➤ Failure of conventional Wildlife legislation to give importance to social issues
- ➤ Increased national commitments under various MEAs.

To address the shortcomings and adapt to the transformations, the department drafted a model Wildlife Act, after years of consultations with various stakeholders.

The bill is in its final stages of approval by the provincial assembly. There is a provision for many new categories of protected areas in the Wildlife Act, including the "Biosphere Reserve". The various categories of protected areas as per new legislation are as in Figure 6.

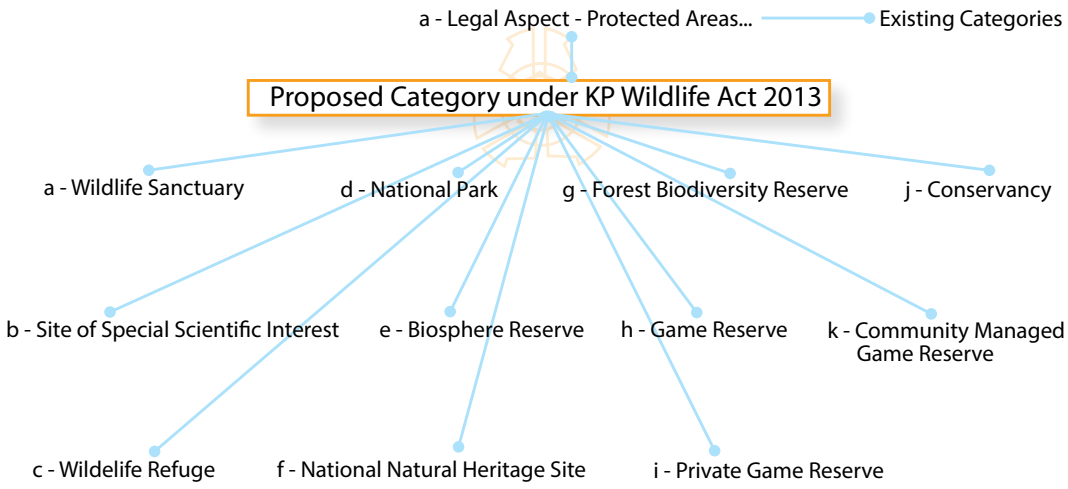


Fig.6. New categories of protected areas under the proposed KP Wildlife Act 2013

Section 30 of the Wildlife Act 2013 reads:
"When an area has a potential for promoting solutions to reconcile the conservation of biodiversity with its sustainable use, Government may, by notification in the official gazette, declare the area to be a Biosphere Reserve, comprising of a core zone, a buffer zone and a mul tiple-use zone, and manage it in the prescribed manner consistent with the UNESCO statutory framework of the MAB".

With the enactment of the new law, the Khyber Pakhtunkhwa Wildlife Department will have the legal authority to declare appropriate areas as Biosphere Reserve.
Candidate sites for potential Bio-Reserves in Khyber Pakhtunkhwa are as follows:

1) Northern Hindukush Biosphere Reserve
This Biosphere Reserve can be declared in area identified by the Pakistan Wetland Project as the "Northern Wetland Complex". It includes Broghil National Park in Khyber Pakhtunkhwa as core zone. It can be a single Biosphere Reserve, which extends from the Wah Khan border on one side and Shandur area on other side, whereas, in Gilgit Baltistan it may include the Handrab and Pandur area. The total area of the core zone i.e., Broghil National Park is 134.744 ha. The terrain is undulating, comprising steep mountains, wide stretching grassy plains and narrow valleys. It has snow-clad mountains, narrow passes and wide meadows. More than 90% of the area is comprised of Alpine and Sub Alpine pastures and rangelands.
Altitude varies from 3281m to 4304m.
The National Park area supports diverse wild animals, including the Himalayan Ibex (*Capra sibirica hemalayanus*), Blue sheep (*Pseudois nayaur*), Snow Leopard (*Uncia uncia*), Brown Bear (*Ursus arctos)*, Wolf (*Canis lupus pallipes*), Golden Marmot (*Marmota caudata*), Snow cock (*Tetraogallus himalayensis*), Chakur partridge (*Alectoris chukar*). Marco Polo sheep (*Ovis ammon polii*) also visit the area as seasonal migrants. Millions of migratory birds also use wetlands of the Yarkhun valley during their migration along flyway 4. As the park is situated at a height above the tree line, it has very limited forests, which are mostly confined to lower parts. Important plant species include Juniper (*Juniperus spp*), Birch (*Betula spp*), Willow (*Salix spp*), Poplar (*Populus spp*). The area is, however, rich in medicinal plants.
The ecological importance of the site is paramount. Out of Global 200 Ecoregions, two Priority Ecoregions can be found in this potential Biosphere Reserve: the "Central Asian Mountain Steppe" and "Tibetan Steppe". It is one of the pristine ecological areas that consist of diverse

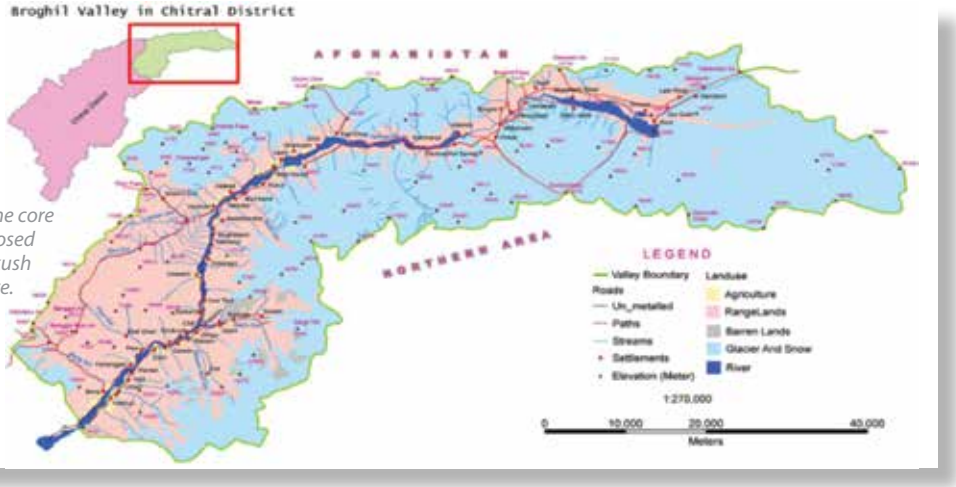


Fig. 7*. Map of the core zone of the proposed Northern Hindukush Biosphere Reserve.*

wetlands, high-altitude peat lands, braided streams and rivers with a number of scenic lakes. It can satisfy the provisions of various conventions, such as the CBD, Bonn, CITES, Ramsar and World Heritage Convention. Declaration of this area as Biosphere Reserve will further boost the efforts of the department for in-situ biodiversity conservation and promotion of ecotourism.

2) Palas–Jalkot / Indus-Kohistan Biosphere Reserve

This Biosphere Reserve can be declared in Indus-Kohistan, of the Hazara Civil Division. Palas Valley can be the core zone of the Biosphere Reserve, whereas the boundary can be extended up to the Allai area, in Batagram District.

The core zone i.e., Palas Valley, has altitudinal variation from 1000 masl - 5151 masl.

Topography is mostly rugged and precipitous. Estimated mean annual precipitation is 900 - 1350 mm (mostly as winter snow).

Lower altitudes experience Dry Sub-Tropical conditions, while higher altitudes experience temperate conditions.

Due to great altitudinal and climatic variation, Palas supports various forest types including:

- ➤ Subtropical Dry Oak Quercus dominated forests and scrub,
- ➤ Temperate forests (including deciduous, mixed and coniferous forests),
- ➤ Sub-Alpine Birch Betula forests, and
- ➤ Alpine Scrub and meadows.

Over 400 plant species have been identified, among which three plant species are new to science, as well as many rare plants. Palas contains the largest known population of the threatened West Himalaya elm (*Ulmus wallichiana*). Over 140 bird species have been recorded in Palas, including the largest known population of the globally threatened Western Trapogan (*Tragopan melanocephalus*). Palas also contains many rare and/or threatened mammal species of the Western Himalayas, including the Mar-

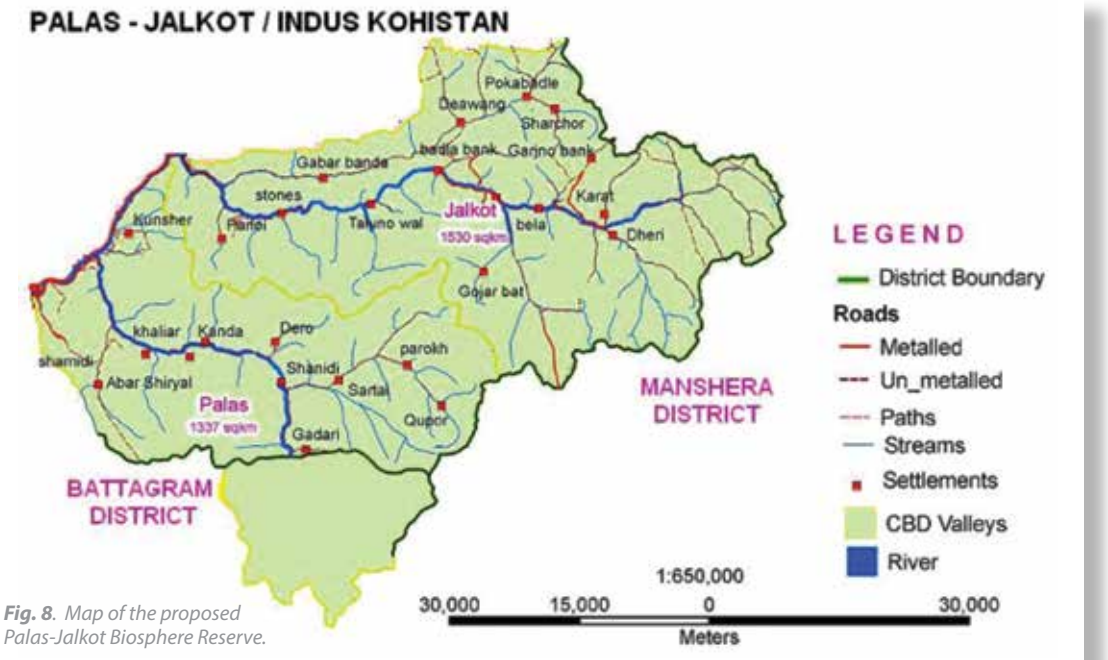


Fig. 8. Map of the proposed Palas-Jalkot Biosphere Reserve.

khor (*Capra falconeri*), Kashmir Grey Langur (*Semnopithecus ajax*), Brown Bear (*Ursus arctos*), Black Bear (*Selenarctos thibetanus*), Wolf (*Canis lupus pallipes*), Snow Leopard (*Uncia uncia*) and Musk Deer (*Moschus moschiferus*). Palas also exhibits a rich diversity of reptiles, amphibians and invertebrates.

3)Swat – Dir Kohistan Biosphere Reserve

This potential Biosphere Reserve may include the areas of Dir-Kohistan and Swat-Kohistan. There are seven valleys including Gawaldai, Sundries, Siasan, Jandri, Badgowai, Kumrat and Loinil in Dir-Kohistan. In addition, there are six valleys in Swat Kohistan, including Bhan, Utror, Gabral, Shahu, Goodar and Mahodand.

Ecologically, the area falls in the Temperate Zone. The floral diversity includes mostly mixed conifer forests and Oak forests, and also Alpine and Sub Alpine meadows. Key floral species are Deodar (*Cedrus deodara*), Blue Pine (*Pinus wallichiana*), Fir (*Abies pindrow*), Spruce (Picea smithiana), Chilghoza pine (*Pinus gerardian*a), Oak (*Quercus dilatata, Q. ilex*), Walnut (*Juglans regi*a), Birch (*Betula utilis*), Poplar (*Populus ciliate*), Yew (*Taxus walliachina*). The associated wildlife includes Markhor (*Capra falconeri falconeri*), Himalayan Ibex (*Capra sibirica hemalayanus*), Black Bear (*Selenarctos thibetanus*), Snow Leopard (*Uncia uncia*), Wolf (*Canis lupus pallipes*), Musk Deer (*Moschus moschiferus*), Snow cock (*Tetraogallus himalayensis*), Monal Pheasant (*Lophophorus impejanus*), Koklass Pheasant (*Pucrasia macrolopha*) and Chakur Partridge (*Alectoris chukar*).

For the sustainable management and conservation of nature and natural resources in general, and wildlife in particular, it is inevitable to involve the local communities of the area in the planning process, along with the sustainable management of the protected areas. Otherwise, custodian communities resist the conservation efforts of the Wildlife Department, questioning: - **why we should bear the cost of conservation?**

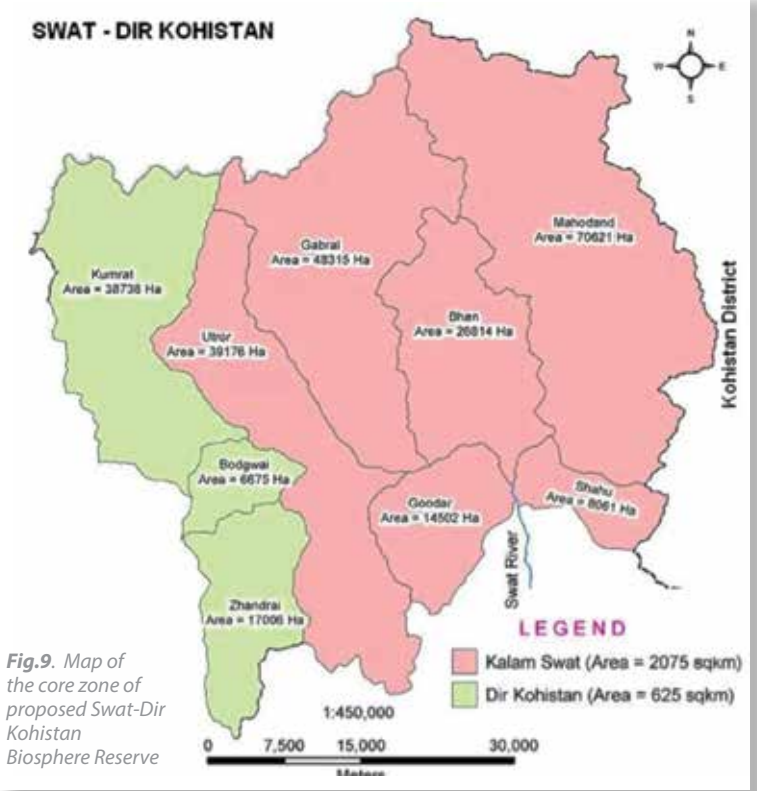


***Fig.9**. Map of the core zone of proposed Swat-Dir Kohistan Biosphere Reserve*

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Climate Change in the Karakorum

1 - Introduction to the session

(**P. Cristofanelli**, *CNR - Institute of Atmospheric Sciences and Climate - Italy; Ev-K2-CNR – Italy)*

A *climate forcer* is any atmospheric compound that disturbs the Earth's planetary energy balance by absorbing or reflecting solar light or infra-red radiation. Since the 18th Century, human activities started to affect the atmospheric composition by changing the average levels of greenhouse gases, aerosol particles and their precursors, both at regional and global level. It is widely agreed that this leads to the global climate change that is currently observed (IPCC, 2013).

The Karakorum is home to hundreds of peaks higher than 6000 m above sea level (a.s.l.), with wide mountain glaciers. Currently, this mountain range is being extensively investigated due to the so-called "Karakorum anomaly", i.e. a general stability of many central Karakorum glaciers versus the general shrinking of eastern Himalayan and Tibetan glaciers. Despite this, changes in the "average" climate of the Pakistan northern areas, the region where the Karakorum is located, have been observed over the last century by the Pakistan Meteorological Department by analyzing surface meteorological data. Moreover, studies carried out in the Upper Indus Basin have reported increasing winter precipitation/decreasing summer temperature over the last two-three decades. Together with the possible transport of short-lived climate forcers (like black carbon and surface ozone) up to the higher mountain, the observed change of meteorological regimes can impact both the mountain cryosphere and the hydrological system, with severe implications to the society and agriculture of the whole country: Karakorum hosts the Upper Indus Basin (UIB), which is one of the main catchment basins which supply irrigation water for Pakistan.

With the aim of strengthening the scientific knowledge about the impacts of climate change on Karakorum, more observations are needed in order to fill the gap of information that still characterizes this complex mountain region, especially in terms of precipitation regimes and atmospheric composition variability.

2 - Ozone and black carbon: short-lived climate forcers in Himalaya-Karakorum

(P. Cristofanelli[1-2], A. Marinoni[1], P. Bonasoni[1-2], E. Vuillermoz[2], M. Alborghetti[2], G.P Verza[2], M. Gallo[2], B. Adhykari[2]

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2 Ev-K2-CNR - Italy)

By the words "short-lived climate forcers" (SLCF), we refer to any atmospheric compound able to exert a climate forcing by modifying the energy budget of the atmosphere, but having a shorter lifetime than carbon dioxide (100 years or more). Black carbon, aerosol particles and ozone (atmospheric life-times of the order of weeks) or methane (lifetime of about 10 years) are recognized as important SLCFs, whose emission reductions can lead to immediate climate and social benefits, especially at the regional scale (see UNEP and WMO, 2012).

BC is the main component of soot, and is directly emitted from many common sources, such as diesel engines, industrial facilities, domestic uses, open fires. It is an efficient absorber of solar radiation, and it can alter the microphysics of clouds (Bond et al., 2013). O_3 is considered as the third most important anthropogenic greenhouse gas after CO_2 and CH_4 and it has been reported to have harmful effects on the human health and agriculture (The Royal Society, 2008).

A thick layer of pollution extends from the Indian Ocean to the Himalayan range during the dry season (especially from November to March), and affects some of the most populous Asian regions. This Atmospheric Brown Cloud (ABC) has significantly altered the radiative forcing over Asia, causing a reduction in the amount of solar energy absorbed at the Earth surface (the so-called "dimming" effect). In addition, due to the presence of absorbing soot and mineral dust, the ABC has increased the annual mean solar heating of the troposphere. Satellite observations showed that the "brown cloud" over the Indo-Gangetic Plains, while extending thousands

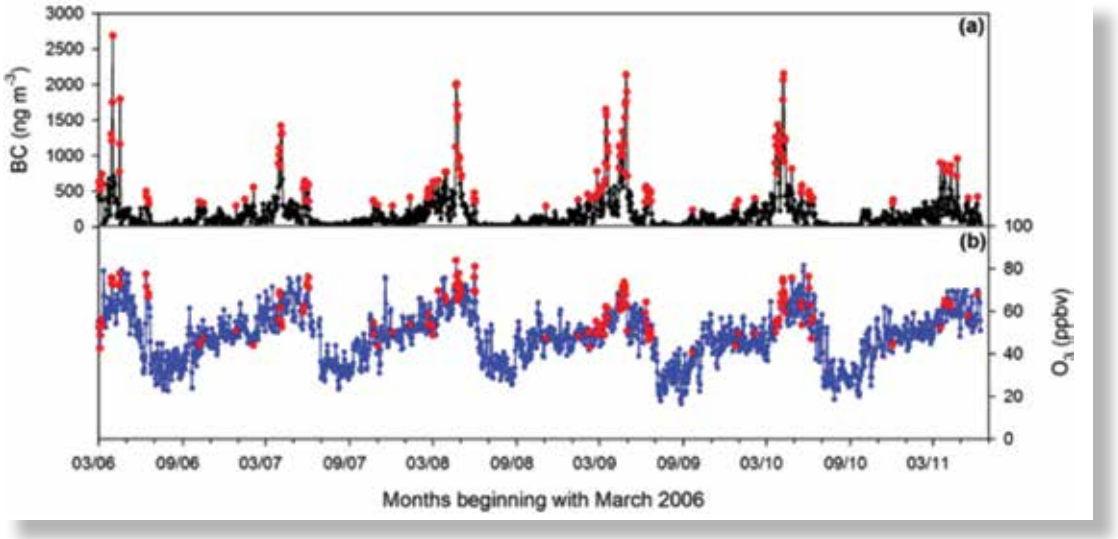

Fig.1. Time series of daily black carbon (BC) and surface ozone (O3) at the NCO-P station (Nepal, 5079 m a.s.l.). The red dots represent the acute pollution events.

of miles southward and over the north Indian ocean during the dry season, is characterized by a sharp boundary to North, due to the barrier of the Hindu Kush – Karakorum - Himalaya (HKKH) ridge. Thus, these high mountain regions can be affected by dust and pollutant-rich air masses. The transport of polluted air masses rich in optically-active aerosol and ozone to mountain regions is a matter of great concern. In fact, as well as influencing the regional radiative forcing of the atmosphere, along with its vertical stability and rain patterns, surface O_3 can strongly affect ecosystems, with possible severe impacts on biodiversity (The Royal Society, 2008) and crops (Agrawal et al 2008). Moreover, high amounts of absorbing aerosols, like BC, can favour atmosphere warming. By modifying snow reflectance after deposition, this alters snowmelt rates and snow spatial coverage, which influences the climate due to snow-albedo feedback and affects hydrological regimes. Since March 2006, a permanent atmospheric observatory, the Nepal Climate Observatory – Pyramid (5079 m asl), is operative in the high Khumbu valley at 5079 ma.s.l. This observatory, a global station of the Global Atmosphere Watch (GAW) of the World Meteorological Organization (WMO) and part of the Atmospheric Brown Cloud UNEP Project, has allowed us to obtain the first continuous information on the export of anthropogenic pollutants and climate-altering compounds to the high Himalayas. As reported in a recent study (Putero et al, 2013), over the period 2006 – 2011, 156 days were affected by "acute" pollution events at the NCP-P (mostly observed during the pre-monsoon) with dramatic increases in BC (352%) and O_3 (29%) levels compared with the remaining days. 56% of these acute pollution events can be linked to the occurrence of open fires over Himalayan foothills (78%), Northern Indo-Gangetic Plain (19%) and Central Asia (3%). Based on atmospheric composition and meteorological observations at the NCO-P, Yasunari et al. (2010) estimated the possible impact of dry deposition of BC on snow melting in high Himalayan glaciers, showing that BC deposition could result in snow albedo reductions ranging from 2.0% to 5.2%, which can lead to an annual runoff increase of 70–204 mm for a typical Tibetan glacier due to the related snow melt. Performing a modelling study with a global climate, Qian et al. (2011) simulated a large BC content (exceeding 150 µg/kg) in snow over the HKKH, due to the export of pollution from the Indo-Gangetic Plains. In particular, over the Hindu Kush–Karakorum, BC deposition in snow can increase the surface air temperature up to ~1.0 K, reducing the pre-monsoon snowpack by as much as 40%, a more efficient reduction than that caused by CO_2 and carbonaceous aerosol increases in the atmosphere since the pre-industrial age. Until now and despite these issues, systematic activities devoted to the characterization of atmospheric composition variability in the Karakorum region are still extremely sparse and there is an urgent need for a more comprehensive documentation and assessment about the quantification of polluted air-mass transport to the Pakistani mountain regions. In summer 2012, a new embedded-transportable

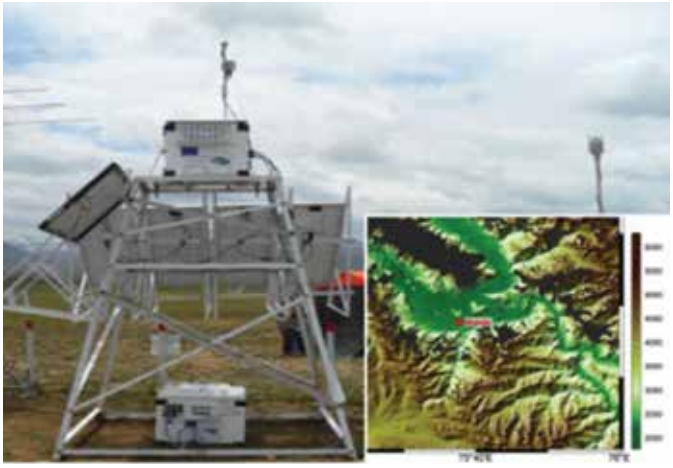

Fig.2. The Remote Climate Station installed at the Deosai Plateau in PakistanThe red dots represented the acute pollution events.

monitoring system, was deployed at the village of Askole (3015 m a.s.l., Pakistan Northern Areas) to obtain preliminary information on atmospheric composition variability in the Karakorum region. Apart from the domestic combustion from the village, which emerged as a possible source of contamination in the valley, the mountain thermal wind regime dominates the diurnal variability of fine particle number O_3 and CO_2. This indicated that the emission of climate forcers occurring at regional scale represents a likely source of pollution for the Karakorum area. To better understand this issue, as well as to contribute to narrowing information gap over Karakorum, an improved version of this transportable system has been running since September 2013 at the Deosai Plateau (4200 m a.s.l.), in collaboration with the PMD Pakistan Meteorological Department and WAPDA. This Remote Climate Station (developed in the framework of the Italian PON Project I-AMICA) is continuously providing information on meteorology, surface ozone, aerosol number concentration size distribution (for 0.28 > D > 10 μm) and equivalent black carbon concentration (Fig. 2).

3 - Climate Change in HKKH Cryosphere - Past, Present and Future perspectives

*(**G. Rasul** - Pakistan Meteorological Department)*

With the aim of providing a robust assessment of the long-term climate variability and changes over the northern Pakistan (which encompasses the Karakorum, the Hindukush as well as the South-western Himalayas), reanalysis records of 111 years for air-temperature and precipitation data extracted from CRU (Climate Research Unit of East Anglia University, UK) data archive have been considered.

The analysis of the area-averaged annual total precipitation amount for the Northern Areas of Pakistan showed an increasing trend from 1901 to 2011, with a linear slope of 0.73 mm yr^{-1}. Increasing trends (with linear slopes of 0.22 mm yr^{-1} and 0.26 mm yr^{-1}) were detected also by segregating the precipitation data for winter (DJF) and monsoon (JJA) seasons.

Over the same period, a positive trend of annual mean temperature was also detected, with an increasing rate of 0.01 °C yr^{-1}. Similarly long-term trends were detected for annual mean maxi-

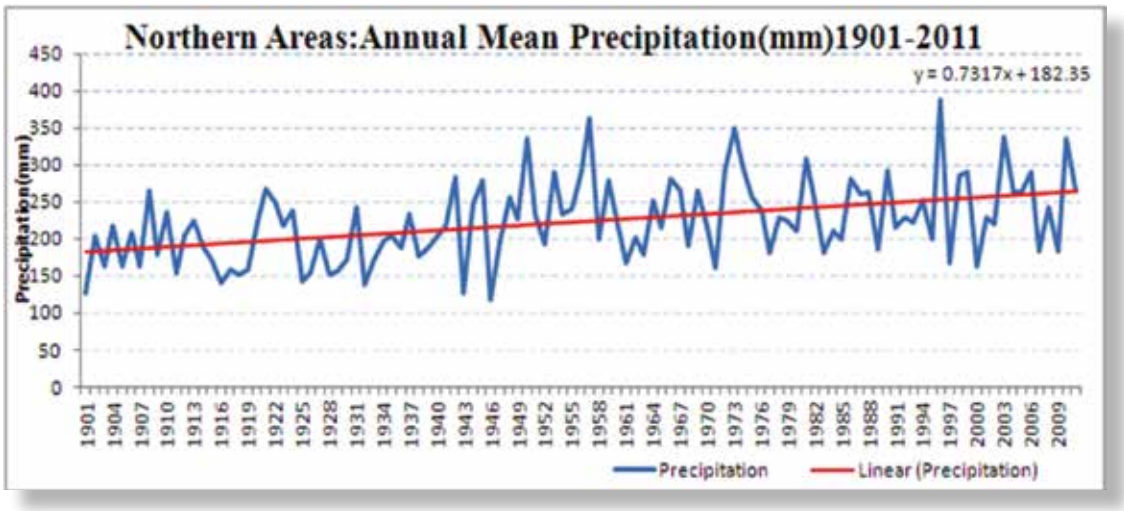

Fig.3. Long-term trend of annual total precipitation (mm) over the Northern Areas of Pakistan (1901 – 2011). Source: CRU Reanalysis Data.

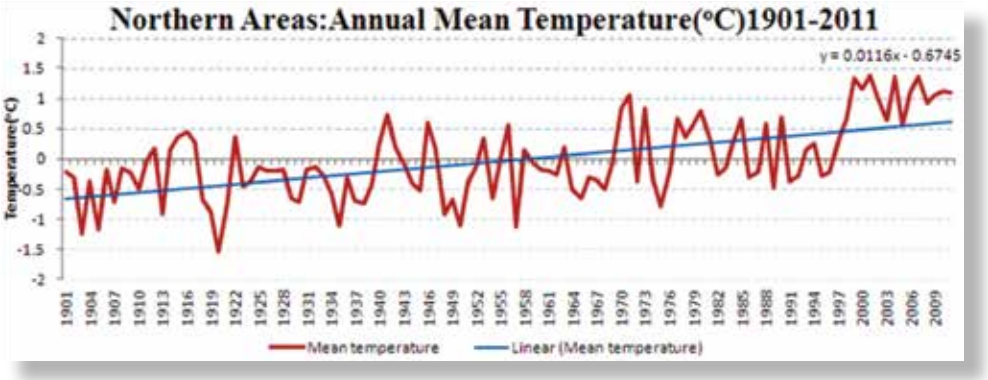

Fig.4. Long-term trend of annual mean daily temperature (C) over the Northern Areas of Pakistan (1901 – 2011). Source: CRU Reanalysis Data.

mum and minimum temperature in the Northern Areas. Comparison of the spatial displacement of average isothermals for the summer maximum temperature, showed a marked shift of the 25°C and 30°C isotherms towards higher elevations and higher latitudes from 1981-1985 to 2006-2010. In particular, while in 1981-1985, the 30°C isotherm was located along the foothills of the mountain rims, during 2006-2010 it was assessed to be well towards the interior of the Pakistan northern areas, clearly indicating a change in the climatic feature of this region.

The accurate estimates have shown an average rise of the 30°C isotherm by 1025m along the mountain slopes since early 1980s. This upward creeping heat has resulted in a snowline shift, with a simultaneous migration of animal and plant species to higher altitudes. The occurrence of heatwaves (i.e. periods characterized by excessively high temperature) were investigated at 5-years intervals from 1981 to 2010, by considering the continuous spell of days >5 for which the daily maximum temperature exceeded 35°C and 40°C.

A general increasing frequency of heat waves has been seen during the period. For the Northern Areas of Pakistan, the first decade of the 21st century (2001-2010) witnessed the highest number of moderate and severe heat waves, which were rare in the past. The persistent occurrence of such heat-infusing events trigger accelerated melting of snow and glaciers, generating peak flows in the rivers and streams. Even if caution should be paid in commenting the changes in the occurrence of such rare events, this is further evidence for the existence of a warming trend over northern Pakistan (Rasul et al., 2011).

The snow-cover estimates for the Northern Areas of Pakistan were calculated from MODIS satellite images from 2001 to 2013, to study the dynamics of snow accumulation peak shift. It has been noticed that snow-deposit maxima have been shifting from January to February with the passage of time (Fig. 5). The bars representing January and February show the total snow cover until the end of these months since onset of the snow season.

This shift reduces the snow residency period, because a sudden rise in temperatures in spring melts the seasonal snow immediately, leaving less time for it to convert into ice through metamorphic processes. Since 2001, snow residency is available for the Pakistani Northern Areas. In general, the snow residency is higher for January than February, and shows a decreasing tendency during the most recent years (from 2006 to 2013, especially for January). Studies are currently on-going concerning the possible impact of black carbon deposition on the melting process of snow and ice. In particular, 5 glaciers are under investigation and preliminary resul-

ts for carbon surface deposition are shown in Table 1. Isotopic analysis has revealed that the sources of deposited black carbon are both indigenous (wood-burning, coal burn carbon) and transboundary eastern sources (industrial carbon). Isotopic analysis of samples collected at different heights in the glaciated areas of Gilgit-Baltistan showed that the reach of the monsoon rainfall has extended to higher elevations. It was found that the origin of the moisture was the Bay of Bengal (BoB).

A meteorological diagnostic study of the zonal component of the monsoonal flow from BoB also proved that the easterly wind has intensified at least up to 700hPa level during the last decade, which drags monsoon rain to higher elevations where its reach was seldom noticed. The impact of the warm monsoon rain water and even warm/moist monsoon winds on glacier ice accentuates the melting process.

For the purpose of providing future projections of climatic parameters, such as temperature and precipitation, dynamical downscaling of Global Climate Models (GCMs) was carried out using Regional Climate Model (RegCM4) under the RCP8.5 scenario. Annual daily mean temperatures and total precipitation were simulated for a reference (baseline) period (1981–2010), as well as for three different future periods: 2010-2039, 2040-2069 and 2070–2099.

The results, provided for 7 locations in the Pakistani Northern Areas (Gilgit, Gupis, Chilas, Bunji, Astore, Babusar, Skardu) showed that a significant increase in surface temperature is expected (Tab. 2), while a less univocal signal can be foreseen for rain/precipitation (Tab. 3).

The expected sharp increase in temperature but almost stable precipitation in the cryospheric zone of HKH may adversely impact the glacier mass balance in future. The phenomenal changes would appear in highly variable river flows, producing extremes in the water cycle variability. The accelerated melt rate may give rise to the formation of glacial lakes, with their overflow occasionally threatening the socioeconomic life of the exposed population. Increasing frequency of heat waves, the rising flux of black carbon and expanding extent of monsoon precipitation are the additional agents causing the depletion of cryospheric reserves of HKH.

Fig.5. Long-term trend of total snow cover at the end of January and February (cumulative) in the Northern Areas of Pakistan(2001 – 2013) comprising SW Himalayas, Karakorum and Hindukush.

Tab. 1. Measured carbon deposition (ng/m²) and median/average particle diameters (µm) for different Pakistani glaciers.

Glacier	Length (km)	Glacier orientation	Carbon deposition (ng/m²)	Average particle diameter (µm)
Hinarchi	17	S	224	131
Hisper	53	NW	161	212
Minapin	16	N	192	401
Gutumi	14	W	105	203
Bualtar	20	NW	63	116

Tab. 2. Mean temperature increases for different future periods under RCP 8.5 scenario against the reference period 1981 – 2010.

Station	ΔT(°C) 2010-2039	ΔT(°C) 2040-2069	ΔT(°C) 2070-2099
Gilgit (1460 m a.s.l.)	1.33	2.90	4.87
Chilas (1250m a.s.l.)	1.10	2.77	4.77
Bunji (1372m a.s.l.)	1.33	2.90	4.87
Astore(2168 m a.s.l.)	1.33	2.90	4.87
Babusar(2900m a.s.l.)	1.10	2.77	4.77
Skardu (2317m a.s.l.)	2.07	4.66	6.55

Tab 3. Mean precipitation variation for different future periods under RCP 8.5 scenario against the reference period 1981 – 2010.

Station	ΔPRP(mm) 2010-2039	ΔPRP(mm) 2040-2069	ΔPRP(mm) 2070-2099
Gilgit (1460 m a.s.l.)	-0.35	11.04	3.02
Chilas (1250m a.s.l.)	-7.14	-7.00	-21.71
Bunji (1372m a.s.l.)	-3.63	-5.73	-13.42
Astore(2168 m a.s.l.)	40.95	40.95	28.33
Babusar(2900m a.s.l.)	-7.14	-7.00	-21.71
Skardu (2317m a.s.l.)	3.21	9.59	6.71

4 - Impact of climate change on Agriculture and Food security in CKNP Area GilgitBaltistan

*(**M. Hussain** - Karakoram International University, Gilgit-Baltistan)*

The Gilgit-Balistan region encompasses 72,4965 km² with a population of 1.2 million inhabitants (population density and growth rate 15 hh/km² and 2.47%, respectively). The territory surface is covered by mountains (36.4%), rangelands (33%), glaciers (24%), forest (9.4%) and agriculture fields (2%). Nonetheless, agriculture and livestock herding represent the principal livelihoods for the resident population. Especially in the mountain areas, livelihoods are traditionally related to mountain agriculture, grazing and farming. Agriculture is mainly carried out on alluvial fans and river traces and its production only reaches subsistence level (less than 2% of land is arable). It is mainly related to cereal crops (wheat barley, maize), horticulture fruits (apricot, ap-

ple cherry, grapes, almond, pomegranate) and vegetables (potato, tomato, peas, cabbage).
The irrigation necessary to carry out this agriculture is strongly dependent on the water availability from ice and snow melt.
As reported by IUCN (2009), mountain ecosystems, life and livelihoods are becoming sensitive to climate change, and the agriculture sector is the most vulnerable to the negative impacts of changing climate.
In particular, agricultural productivity can be significantly affected by climate change variability, especially changes in the average level and variability of temperature, rain and snow precipitation, air humidity, atmospheric pollution, floods and land stability.
Some specific issues have already been raised in the Gilgit-Balistan region concerning the effect of current climate change on fruit and vegetable cultivation (see example in Figure 6).

Such evidence underlines the necessity to adopt specific mitigation measures for adapting the mountain agriculture to the change in the meteorological regime and climatic conditions and specifically:

- Change in cropping calendar (date of sowing/harvesting).
- Change in cropping pattern: substitute the low profit crop barley and millet, to vegetable crops, like potatoes, tomatoes as cash crops.
- Weather forecasting: to keep the farmers aware of coming weather conditions, especially during the crop maturity stage.
- Introduction of crop varieties adapted to changing climatic conditions
- Resistance to pests and diseases.
- Adopt modern planting techniques instead of traditional practices.
- Adopt organic farming, encourage FYM and reduce chemical fertilizer use.

Fig.6. Some examples of fruit diseases observed in the Gilgit-Balistan Region.

5 - Karakorum cryosphere response to climate change: Anomalies and Research Efforts

*(**M. Zia ur Rahman Hashmi** - Global Change Impact Studies Centre - GCISC - Pakistan)*

Climate change has serious implications for Pakistan's water resources due to their strong dependence on glaciers.
For this reason, to assess climate change impacts on the Karakorum cryosphere in a more proper way, there is a need to explore new dimensions of research, in addition to glacier mass balance studies. GCISC has an important role in building the country's resilience to climate change and GCISC capacities are increasing in terms of glacier mass balance studies for Pakistan, through involvement in field measurements and learning the use of advanced RS/GIS tools and techniques and advanced glacio-hydrological modelling. As reported by the World Glacier Monitoring Service, measurements taken over the last century clearly reveal a general shrinkage of mountain glaciers on a global scale. This behavior is observed also in the Hindu Kush-Karakorum-Himalaya region, where glaciers are losing mass, with markedly greater loss in the past decade than earlier.
On the other hand, it is well understood that in the Karakorum, specifically, a general stability of many glaciers is observed, leading to the so-called "Karakorum anomaly". For instance, Scherler et al. (2011) pointed out that of 42 studied glaciers in the Karakorum region, 58% appear to be advancing/stable and only 42% retreating. Such findings have been reported in a number of other studies (Hewitt, 2005; Bishop et al., 2008; Hewitt, 2011; Copland et al., 2011; Scherler et al. 2011; Gardelle et al., 2012; Cogley 2012; Sarikaya et al., 2012; Kääb et al.,

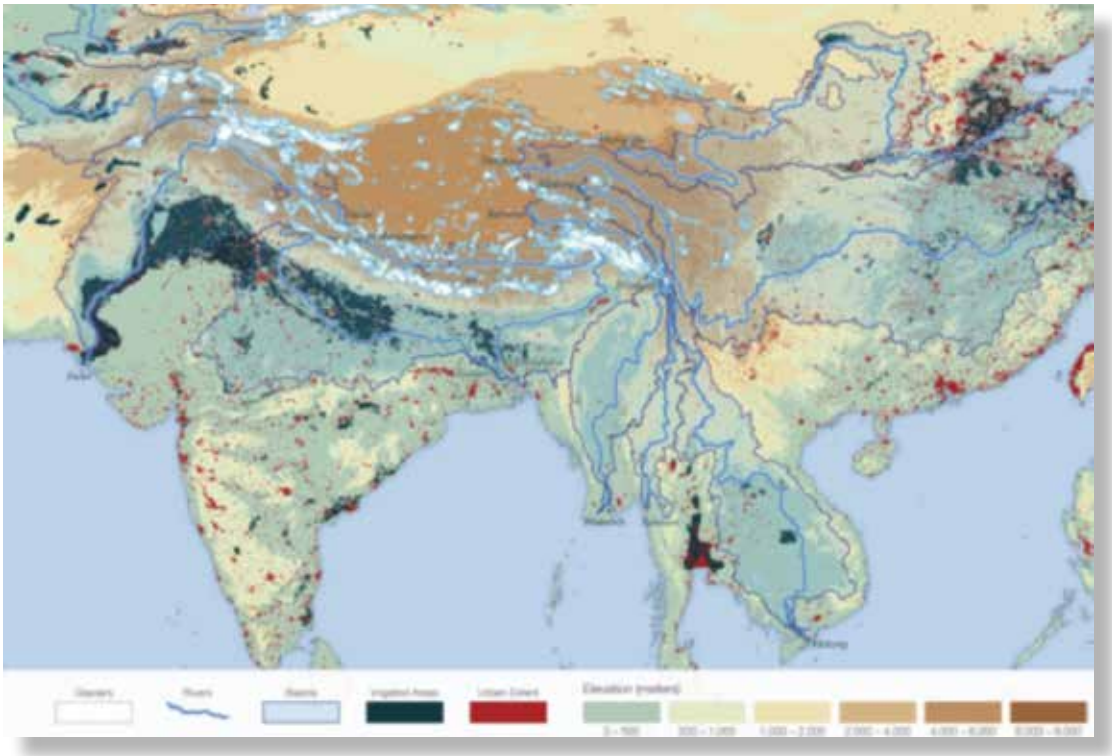

Fig 7. South Asia topography and glacier extension.

2012; Janes and Bush 2012; Wiltshire, 2013). Some studies suggested that a possible cause for the "Karakorum anomaly" can be related to the debris cover which generally characterizes the Karakorum glaciers and can have a significant influence on glacier terminus dynamics. Another factor able to explain this behavior is the different weather regime affecting Karakorum, as compared to the Hindu Kush – Himalayas: while the former is directly affected by westerly weather pattern (with a peak of precipitation in spring-winter), the latter are more directly impacted by the South Asian monsoon system. Analyses of climate data support the slow response of Karakorum Glaciers to changing climate. For example, Bocchiola and Diolaiuti (2012) analyzed monthly data from "hill stations" managed by the Pakistan Meteorological Department in the upper Karakorum, pointing out a slight decrease in summer air temperatures and an increase in Winter precipitation for the period 1980–2009, possibly leading to increasing snow covered area.

With the aim of contributing to climate change research in Karakorum region, GCISC has been involved in several research programmes and projects, with the goal of assisting national stakeholders and policymakers in adopting correct measures and policies concerning climate change mitigation/adaptation, as well as raising public awareness.

In particular, activities towards the development of climate change projections using Regional Climate Model and the assessment of climate change impacts on Pakistan's water resources and agriculture, are routinely carried out by different Sections of the Centre. In this context, a number of international collaborations have been established (Table 4).

Tab. 4. International collaboration at GCISC

Institution	Country
APN - Asia Pacific Network for Global Change Research	Japan
ASICTP Abdus Salam Int. Centre for Theoretical Physics	Italy
IIASA Int. Inst. for Applied Systems Analysis	Austria
NCAR National Centre for Atmospheric Research	USA
GECAFS Global Environment Change and Food System	UK
ICIMOD International Centre for Integrated Mountain Development	Nepal
UNC University of Newcastle	UK
EvK2CNR	Italy

As an example of recent activities, a summer field campaign was carried out in 2013 on the Baltoro Glacier (Fig. 8) for investigations on glaciology, hydrology and atmosphere, for the specific purpose of assessing the current status of the Karakorum glaciers under the current climate change.

Fig. 8: Established camp on the Baltoro glacier during the summer field campaign 2013.

Currently, the Water Research and Glaciology Section of GCISC in particular is working on:

➤ Statistical downscaling of meteorological data for use in hydrology studies, using Weather generators and Regression-based techniques

➤ Analysis of extreme hydro-meteorological events under changing climate

➤ Assessing future flows in Upper Indus Basin under different climate change scenarios using downscaled data in hydrological models to investigate

- Water availability in the near future (first few decades) and far future
- Changes in the Intra-Annual pattern of river flows
- Uncertainty assessment

➤ Resistance to pest/ diseases.

➤ Assessing climate change impacts on mangrove forests in the Indus Basin delta;

➤ GLOF event hazard assessment and intervention to strengthen the resilience of the vulnerable communities living in the Northern region of Pakistan

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Glaciers, Snow and the Hydrological Cycle in Northern Pakistan

1 - Introduction to the session

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The mountain range of the Hindu Kush, Karakorum and Himalaya (HKKH) contains a large amount of glacier ice, and it is the third pole of our planet (e.g. Smiraglia et al., 2007; Kehrwald et al., 2008), delivering water for agriculture, drinking purposes and power production. There are estimates indicating that more than 50% of the water flowing in the Upper Indus Basin UIB, in Pakistan, is due to snow and glacier melt (Immerzeel et al., 2010). Economy of Himalayan regions relies on agriculture, and is therefore highly dependent on water availability and irrigation systems (e.g. Akhtar et al., 2008). The Indo-Gangetic plain (IGP, including regions of Pakistan, India, Nepal, and Bangladesh) is challenged by increasing food production, and any perturbation in agriculture will considerably affect the food systems of the region and increase the vulnerability of the resource-poor population (e.g. Aggarwal et al., 2004; Kahlown et al., 2007). While southern Himalaya is strongly influenced by the monsoon climate and by abundant seasonal precipitation, the meteo-climatic conditions of Karakorum suggest a stricter dependence of water resources on snow and ice ablation, and therefore the area is in need of reliable projections for the future (Mayer et al., 2010).

The HKKH stores a very important amount of water in its extensive glacier cover at higher altitudes (about 16,300 km^2), but the lower reaches are very dry. The state of the glaciers plays an important role in future planning. Shrinking glaciers may initially provide more melt water, but

later their amount may decrease. On the other hand, growing glaciers store precipitation, reduce summer runoff, and can also generate local hazards. Along the HKKH range there is a considerable variability in climate conditions, including varying sources and types of precipitation (e.g. Bocchiola and Diolaiuti, 2013), influencing the behaviour and evolution of the cryosphere. The most recent observations of glacier fluctuations indicate that in the eastern and central HKKH glaciers are subject to general retreat, and have lost a significant amount of mass and area (Salerno et al., 2008, Bolch et al., 2011). Rapid declines in glacier area are reported throughout the Greater Himalaya and most of mainland Asia (Ageta, and Higuchi, 1984; Ageta, and Fujita, 1996), widely attributed to global warming (IPCC, 2001; 2007), but changes in climate and glaciers geometry are not uniform. Positive ice mass balances and advancing glaciers have been reported in the Karakorum mountains during the last decade, in spite of worldwide glacier decline (Hewitt, 2005). Glaciers in the Eastern part of the HKKH receive accumulation from precipitation during the Indian monsoon in summer, whereas in the West snow fall occurs mainly in Winter, through Westerly atmospheric circulations (Bookhagen and Burbank, 2010, Kääb et al., 2012, Fowler and Archer, 2006; Winiger et al., 2005). This variability in accumulation conditions may be one reason for the large spread in glacier changes within the region (Bolch et al., 2011; Kääb et al., 2012). Among others, Kääb et al. (2012) used satellite laser altimetry to show widespread glacier wastage in the eastern, central and south-western parts of the HKKH during 2003-08, while in the Karakorum glaciers seem to have thinned by a few centimeters per year. Some studies display not only balanced to slightly negative mass budgets in the Karakorum range, but even an expansion and thickening of the largest glaciers, mainly in the central Karakorum, since the 1990s, accompanied by a non-negligible number of rapid glacier advances (i.e.: surge-type phenomena, see among the others Diolaiuti et al., 2003; Hewitt, 2005; Barrand and Murray, 2006; Belo' et al., 2008; Mayer et al., 2011; Copland et al., 2011; Minora et al., 2013).

This situation of stagnant and advancing glaciers in the highest parts of central Karakorum was called "Karakorum anomaly" by Hewitt (2005), and more recently the "Pamir-Karakorum Anomaly", as proposed by Gardelle et al. (2013). In general, glaciers in the Karakorum range seem to be less affected by the global trend of negative glacier mass balance, with frequent observations of advancing glaciers. This behavior might be a consequence of the generally high elevations of glacier bodies in this area, combined with a possible increase in orographic precipitation, leading to enhanced accumulation. These observations were explained with the recent climate peculiarities, i.e. i) a decreasing trend in maximum and minimum temperatures in some periods within the Karakorum range, and ii) an increase in winter precipitation (Archer and Fowler, 2004; Bocchiola and Diolaiuti, 2013). The negative temperature trend during summer is consistent with the observed advance and thickening of some Karakorum glaciers, and the reduction in runoff shown by some gauging station data from heavily glacierized catchments (e.g. Hunza basin, Hewitt, 2005; Archer, 2003).

Tahir et al. (2011) studied the snow cover dynamics (using Modis data during 2000-2009) and hydrological regime (using daily hydrological fluxes during 1966-2008) of the Hunza River basin, Northern Pakistan. They found a slight expansion of the cryosphere in the area, in contrast to most of the regions in the world, where glaciers are melting rapidly. This could result from an increase in winter precipitation caused by westerly circulation, and potentially provides shielding of glaciers against solar radiation.

Bocchiola and Diolaiuti (2013) investigated recent (1980-2009) climate variability in the upper Karakorum studying, among others, monthly data of total precipitation, wet days, maximum and minimum air temperature for 17 weather stations. They found substantially unchanged

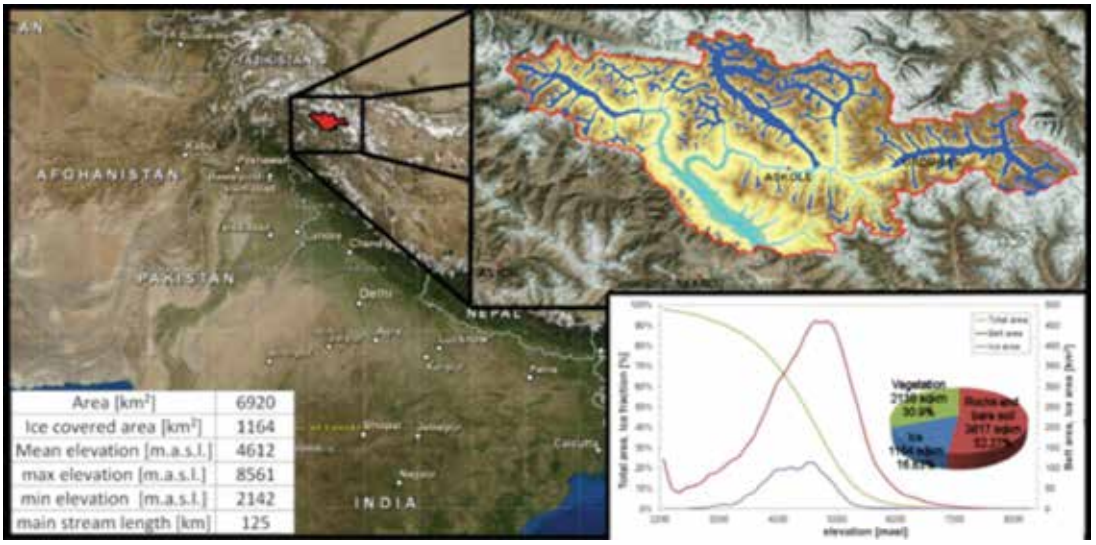

Fig. 1. The Shigar river in study.

total precipitation, but an increasing number of wet days during winter in the Gilgit area, potentially implying more snowfall events at highest altitudes, and minimum temperatures increasing except in Summer, when decreasing values are detected in Gilgit.

Maximum temperatures were found to increase everywhere. Minora et al. (2013) studied glacier evolution (2001-2010) within the Central Karakorum National Park CKNP, nesting Shigar's river highest share and all glaciers, by means of Remote Sensing data (i.e. Landsat images), and found not significant area change. Using MODIS data, they also found increasing (2001-2011) snow covered areas at thaw (June-September). They further detected a considerable rise in supraglacial debris coverage, which could have contributed to reducing buried ice melt during the last decade.

The glaciological and hydrological regimes of HKKH rivers and the potential impact of climate change therein have been recently assessed in a number of contributions in the available scientific literature (e.g. Aizen et al., 2002; Hannah et al, 2005; Kaser et al., 2010; Bocchiola et al., 2011).

Akhtar et al. (2008) investigated hydrological conditions pending different climate change scenarios (PRECIS model, A2 storyline) for three glacierized watersheds in the Hindukush–Karakorum–Himalaya (Hunza, 13925 km^2, glacierized 4688 km^2; Gilgit, 12800 km^2, glacierized 915 km^2; Astore, 3750 km^2, glacierized 612 km^2). Their results indicate temperature and precipitation increase towards the end of the 21st century, with discharges increasing for 100% and 50% glacier cover scenarios, whereas noticeable decrease is conjectured for the 0% scenario, i.e. for depletion of ice caps. Immerzeel et al. (2009) used remotely sensed precipitation (from TRMM) and snow covered area SCA (from MODIS®), together with ground temperature data and a simple Snow Melt Runoff Model (SRM), to calibrate a hydrological model.

They then projected forward in time (PRECIS model, 2071–2100) the hydrological response of the strongly snow fed Indus watershed (Pakistan, NW Himalaya, 200.677 km^2, including the Hunza and Gilgit basins). They found warming in all seasons, greater at the highest altitudes, giving diminished snow fall, whereas total precipitation increased by 20% or so. They found snow melt peaks shifted up to one month earlier, increased glacial flow due to temperature,

and significant increase in rainfall runoff.
Bocchiola et al. (2011) preliminarily studied prospective (until 2059) hydrological behavior of the Shigar river, nested within the UIB. They used simple a hydrological model, including snow and ice ablation, and tuned against historical average monthly values from literature, to depict hydrological fluxes. Then, they used future (2050-2059), locally adjusted, precipitation and temperature fields from the CCSM3 model (A2 storyline) to depict future hydrological behavior of the river, under four different ice cover scenarios (unchanged, -10%, -25%,- 50%). Average yearly discharge under these scenarios would increase considerably, depending upon the assumptions concerning ice cover.
Namely, mean discharge would grow up to twice the present values for 100% ice cover, and decrease below the present values for ice cover between 50% and 25%. The Shigar river is paradigmatic of high altitude catchments in the upper Karakorum, and may be classified as an ungauged catchment, given that stream flows have not been measured since 1997 (and were available to the authors in the form of average monthly values 1985-1997, as reported), and little meteorological, nivological, and glaciological information was at hand. The study of Bocchiola et al. (2011) was published as part of the Prediction in ungauged basins PUB initiative, launched by the International Association of Hydrological Sciences (IAHS, Sivapalan et al., 2003; Seibert et al., 2009). High altitude glacierized catchments, such as Shigar here, represent typical grounds of application of PUB concepts, where simple hydrological modeling based upon scarce data is necessary for glaciers' mass balance assessment, water budget estimation, and prediction under climate change conditions (e.g. Chalise et al., 2003, Konz et al., 2007; Immerzeel et al., 2009; Bocchiola et al., 2010). Further research towards this end is required. Presentations within this session deal with issue of depicting present and prospective dynamics of ice bodies in the Karakorum area, and the hydrological cycle therein.

2 - Water resources and hydrological regimes of the upper Indus basin and CKNP: results from SEED project

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We built here upon the study by Bocchiola et al. (2011), and on results from field activities, aimed at increasing data coverage as much as possible, to strengthen our knowledge of physical processes underlying the hydrology of the Shigar river area, and carry out hydrological projections based on updated climatological tools.
The present work improves on former work thanks to the *I*) use of hydrological fluxes gathered at a hydrological station installed ad hoc, during year 2012, *II*) use of ice melting factors explicitly evaluated during field campaigns in 2011-2012, *III*) use of supraglacial debris cover data explicitly gathered in situ during 2011-2012, *IV*) use of ice velocity data gathered during 2011-2012, *V*) set up of a simple model of ice cover dynamics to avoid inconsistent "static" glacier cover, *VI*) validation of the snow cover module by way of high altitude snow accumulation data gathered during summer 2011, and *VII*) building of hydrological projections until 2100 based upon climate projections from three GCMs (EC-Earth, ECHAM6, CCSM4), using recently delivered representative concentration pathways, RCPs.
As a result, our picture of the hydrological regime of the Shigar river, and projection of its future behavior should be more credible.
This study builds on the activity carried out within the SEED project, aiming at evaluating the impact of climate change upon hydrology of the upper Indus river, and focusing upon the Shigar river. Fulfillment of the project included, among

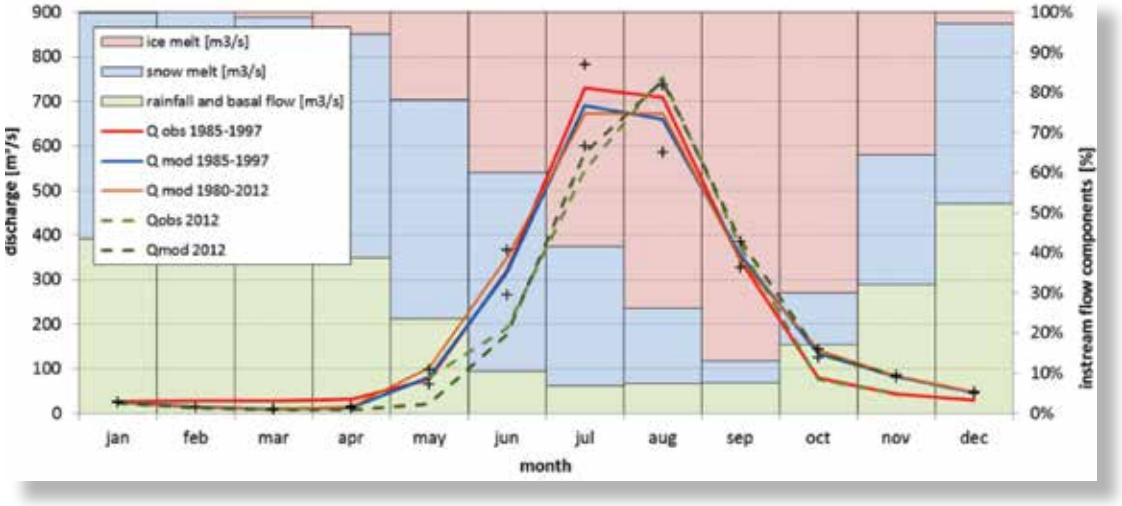

Fig. 2. Shigar river. Flow components (rainfall, ice melt, snow melt) as estimated by the model.

others, hydrological and glaciological field expeditions, for the purpose of characterizing water resources delivery from the Shigar river.

The results demonstrate that a simple, properly tuned hydrological model may depict fairly well monthly discharge as measured during 1985-1997, and daily discharges at Shigar specifically measured during year 2012.

Considerable streamflows start during June, peaking in July/August, with negligible flows already in November. Snow melt provides a considerable contribution (up to 50%) to in-stream discharge always, except during Summer. Ice melts starts during Spring, and may reach a share of 805 or more during late Summer, then decreasing until December. Rainfall provides a considerable share of runoff during Winter and Spring. Globally, it is clear how the Shigar river's hydrological regime is regulated by snow and ice melt amount and timing.

The results of the projection exercise show that the future climate for the century in this area is projected to be warmer, and probably wetter, and ice bodies may be expected to start significant down wasting in the second half of the century. As a result, a likely intensification of the hydrological cycle will occur within the CKNP area. On the one hand, the hydrological regime of the CKNP will maintain its unimodal shape, driven by snow and especially ice melt, and monsoonal rainfall, thus providing acceptable water resources supply.

On the other hand, larger floods will be likely to occur during the warm season.

Given that towards the end of the century glaciers will down waste considerably, it is to be assessed what the effect might be of a large loss of glacier volume, potentially occurring even after 2100. Water management in the Upper Indus Basin under the prospective situation as projected will therefore require increased attention to flood hazard assessment and flood emergency planning and management.

Lastly, down wasting of ice bodies is expected within the first half of the century, a trend possibly mirroring the peculiarity of the present "Karakorum anomaly". However, towards the end of the century, glacier shrinkage is expected.

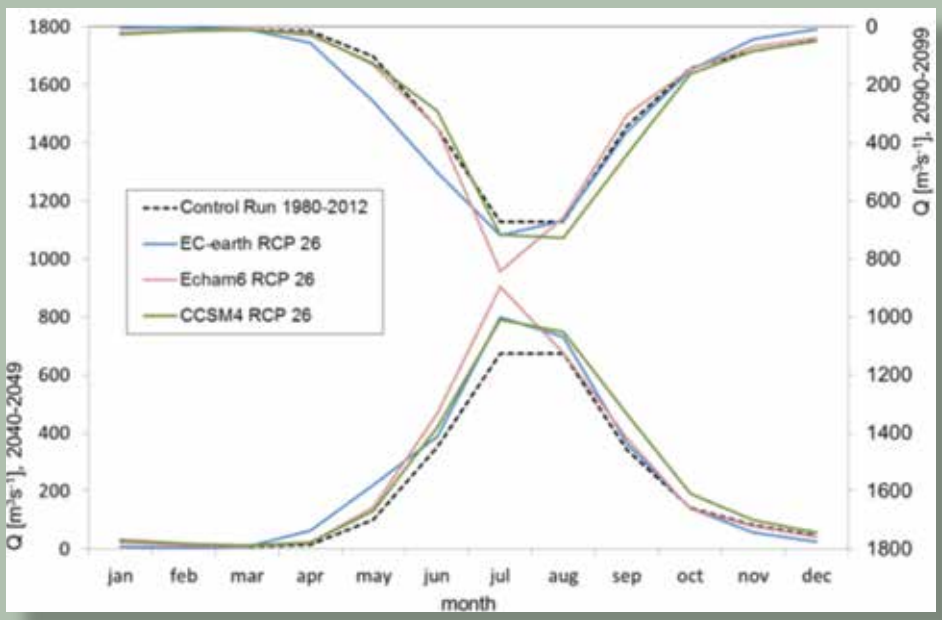

Fig. 3. Shigar river. Monthly discharge as simulated by the model under climate change scenarios from the three GCM models (RCP26).

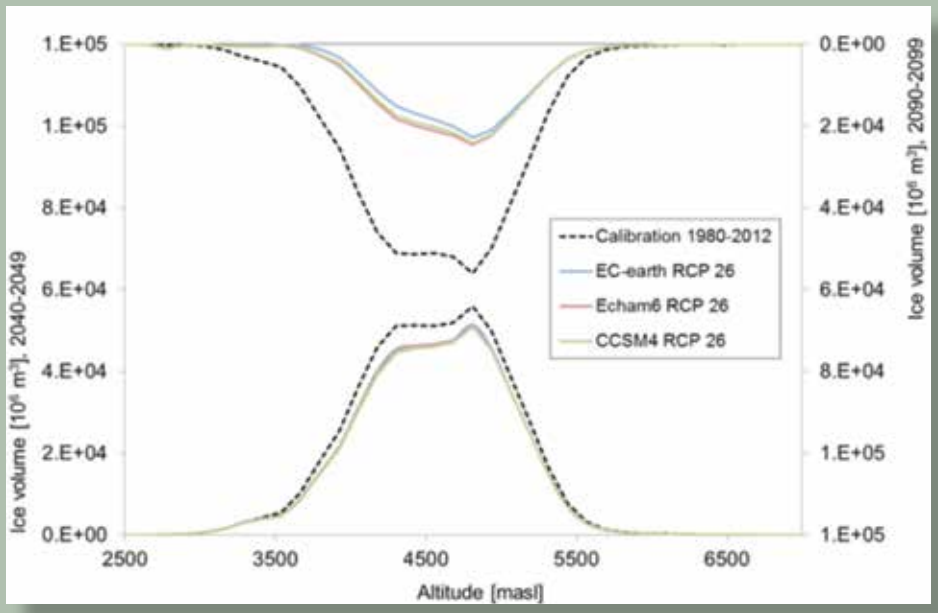

Fig. 4. Ice volume as per altitude belts upon the Baltoro glaciers, as simulated by the model under climate change scenarios from the three GCM models (RCP26).

3 - The Karakorum Anomaly : Indications based on observations, field data, models in Upper Hunza

(M. Winiger[1] and U. Boerst[1]
1 University of Bonn - Germany)

The authors focus upon the existence and extent of the Karakorum Anomaly. Contrasting results arise in the study of glacier dynamics, with some glaciers retreating, and some surging, thus making investigation and drawing of conclusions less simple than in other areas worldwide. Down melting of glaciers indeed may carry favorable consequences upon irrigation potential in irrigation potential, but may also increase flood risk, and water deliver and flood dynamics therein need to be predicted. The authors illustrate the paradigmatic case of the Upper Hunza catchment, displaying a noticeably modified hydrological regime and morphology during the last four decades. However, the water balance of a high altitude glacierized area is of complex determination, because several processes need be investigated, and gathering of data is extremely difficult. As an example of a water budget of a Karakorum glacierized area, the authors present the Batura catchment. Measured discharges within the Batura river yield a specific runoff (as per surface area) during 1974 to 2012 ranging from 1253 mmy^{-1} to 2059 mmy^{-1}, with the largest available value in 1990.

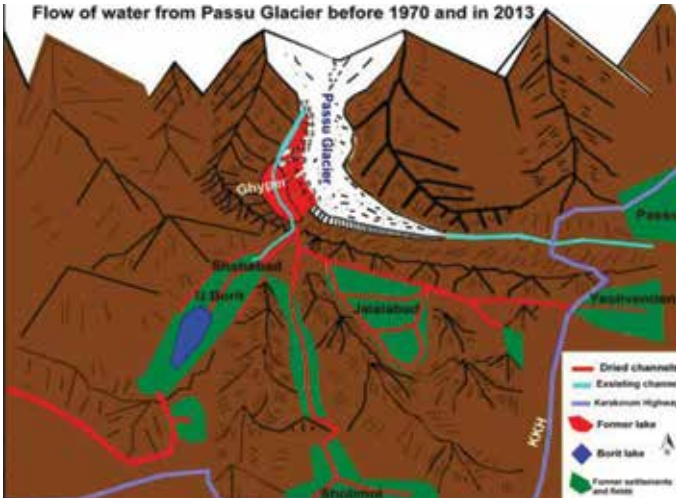

Fig. 5. Modified hydrological dynamics of Passu glacier during the last four decades.

Processing of remote sensing images of Batura glacier (1974-2000) allowed the estimation of water gains and losses, depending on altitude, allowing the assessment of mass balance.

Batura glacier gained ca. 87 mmy^{-1} in water equivalent, thus displaying an increase in volume. Therefore, ground investigation and modeling provides evidence of a potential gain in mass of some glaciers (like Batura here) over the last four decades, and potentially decreasing stream discharge. In turn, the expectation of decreasing water within the Indus river, delivering water to Pakistan's population through an intricate system of reservoirs and channels, raises concerns that in the future the increasing population of Pakistan may face a water shortage.

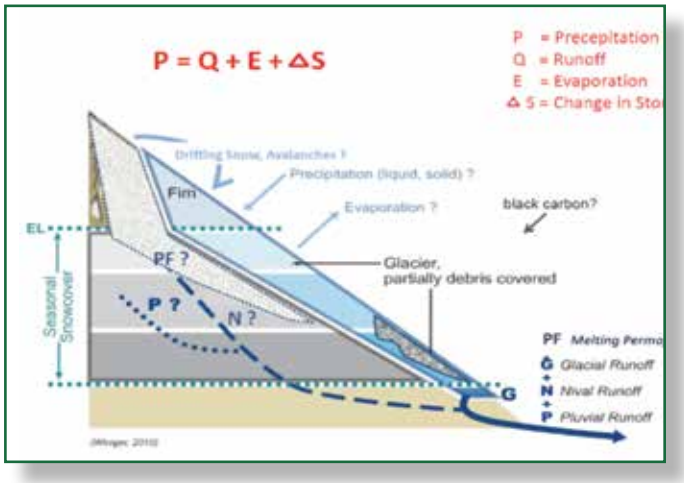

Fig. 6. Sketch of simplified water balance of a glacierized catchment.

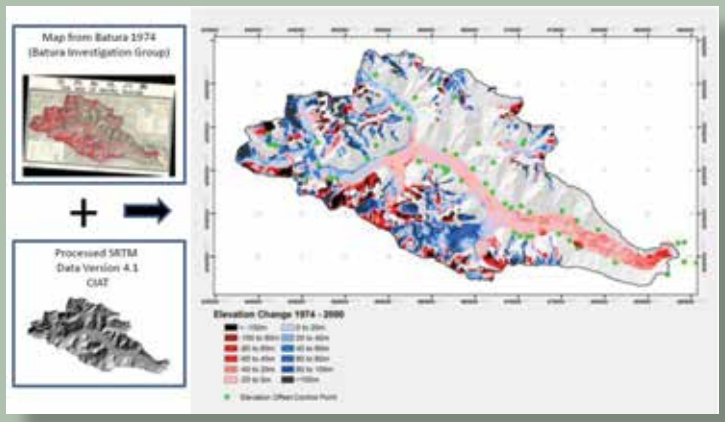

Fig. 7. Batura glacier elevation change during 1974-2000.

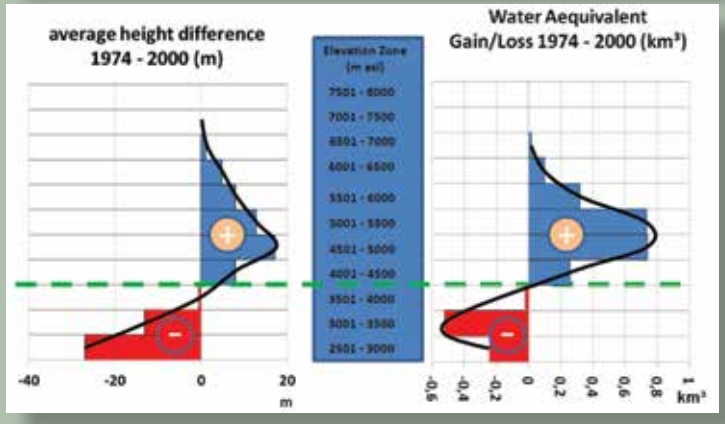

Fig. 8. Batura glacier. Gain of Ice from 1974 – 2000. Ice, 1,7 km³ = 1,5 km³ water. Equivalent ca. 87 mmy-1.

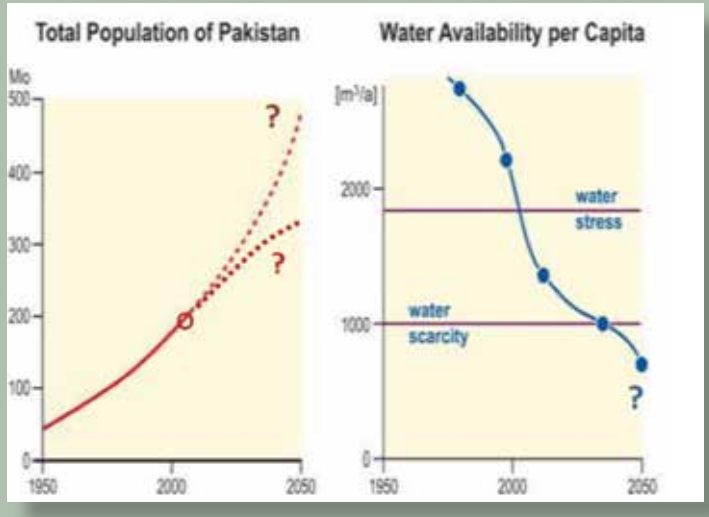

Fig. 9. Sketch of potential future increase in population in Pakistan, with potential decrease in water availability per capita.

4 - The glaciers of the Central Karakorum, inventory of an important resourcea SEED initiative

(C. Mayer[1-2], A. Lambrecht[3], U. Minora[4], L. Bonetti[4], C. D'Agata[4], C. Smiraglia[2-4], G. Diolaiuti[2-4]
1 Bavarian Academy of Sciences and Humanities Kommission für Glaziologie - Gemany
2 Ev-K2-CNR - Italy
3 Regional Environmental Protection Agency (ARPA), Lombardy - Italy
4 Department of Earth Sciences "Ardito Desio", University of Milan - Italy)

Karakorum is one of the most glacierized regions worldwide, and its glaciers are the main water resource of Pakistan.
The attention paid to this area is increasing, because the evolution of its glaciers recently depicted a situation of general stability, known as the "Karakorum Anomaly", in contrast to glacier retreat worldwide. Here, the authors focus attention on glacier evolution within the Central Karakorum National Park (CKNP, the newborn park of this region, ca. 12162 km^2 in area, focus area of the SEED project), to assess the magnitude

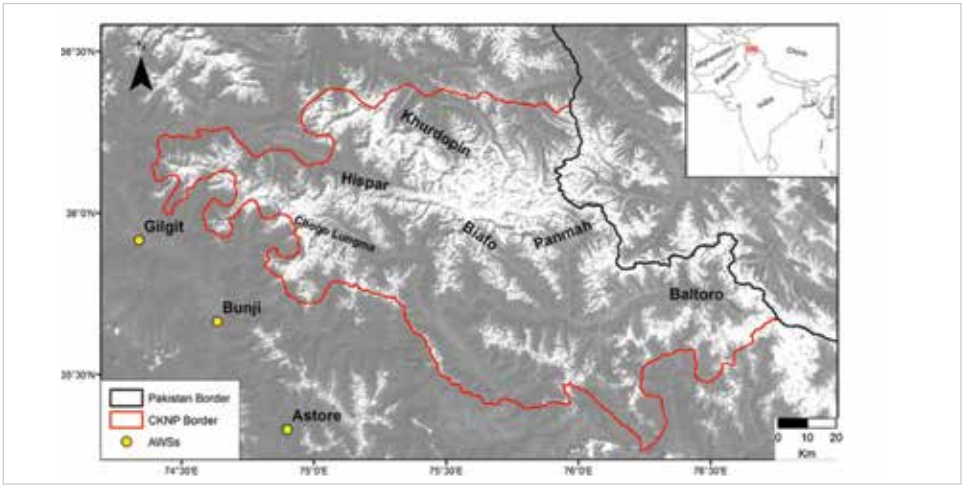

Fig. 10. CKNP park and glaciers therein.

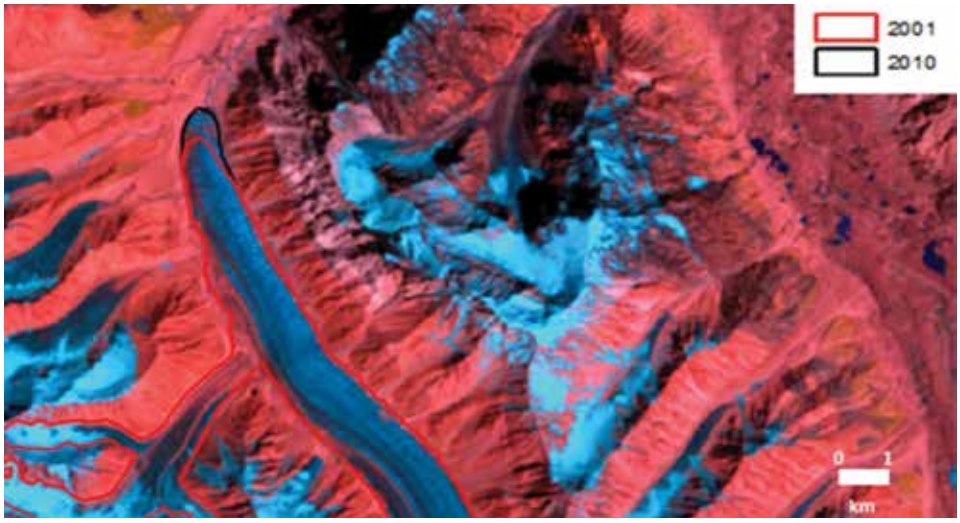

Fig. 11. Example of an advancing glacier terminus near Braldu glacier from 2001-2010.

and rate of this anomaly. By means of Remote Sensing data (i.e.: Landsat images), the authors analyzed a sample of more than 700 glaciers, and they found that the area change between 2001 and 2010 was not significant (+27 $km^2 \pm 42$ km^2), thus confirming their stationarity.
Climate and snow data suggest that a slight decrease in summer temperatures and an increase in wet days during winter, possibly increasing snow-cover duration, may have contributed to maintaining a more stable glacier area, in spite of global warming, leading to general glacier shrinkage worldwide.
Then, the authors presented some preliminary results from field campaigns carried out during 2011-2013 upon the Baltoro glacier, in fulfillment of SEED project.
Conclusions of the study suggest that *I*) glaciers in the Karakorum are more stable than in other regions, *II*) glacier area change is mainly due to fast glacier advances, *III*) debris covered glaciers loose mass by elevation change, and not by area change, and *IV*) the long term evolution of large glaciers is negative.

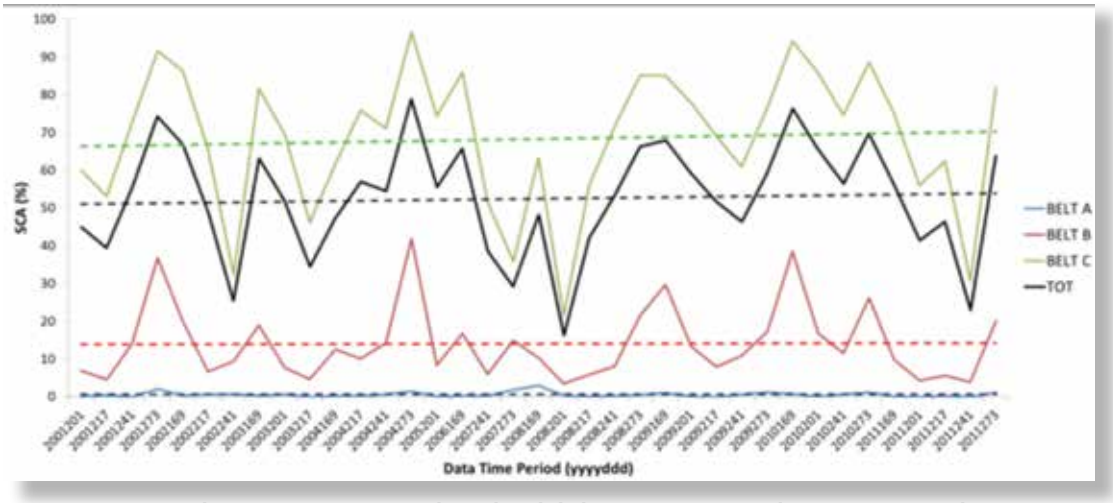

Fig. 12. Snow cover during 2001-2011, as per three altitude belts (A:1900-3300 m asl, B: 3300-4300 m asl, C: 4300-8400 m asl).

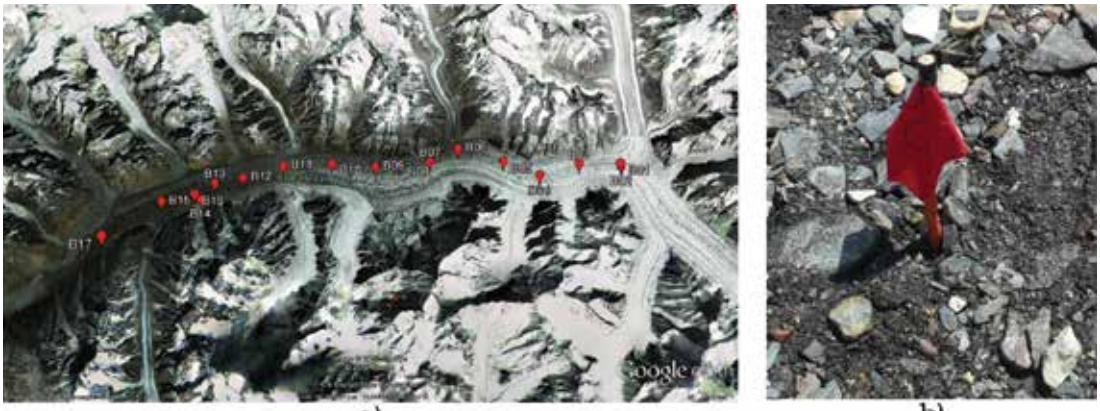

Fig. 13. Baltoro glacier. Ice ablation measurements campaign 2011-2013. a) Ablation stakes. b) Detail of a ice stake.

5 - Initiatives of WAPDA in Monitoring Upper Indus Basin

*(**D. Hashmi** - Glacier Monitoring Research Centre - WAPDA - Pakistan)*

Tremendously important. The Water and power Development Authority of Pakistan WAPDA, created in 1958, is actively engaged in studying the Upper Indus Basin cryosphere, and in establishing a hydro-meteorological network since the 1960's. Snow surveys were also carried out during 1961 to 1968 in some catchments, including Mangla Basin, to forecast flows into the Mangla Dam. During 1975-1978 Landsat imagery was used by WAPDA to investigate the water resources of Pakistan. Very good correlation between depletion of UIB snow cover area with increasing UIB flows during snowmelts period was established. During 1985-1989, to understand the cryospheric and hydrological conditions of UIB, ground-based research was carried out by WAPDA, in collaboration with Canadian

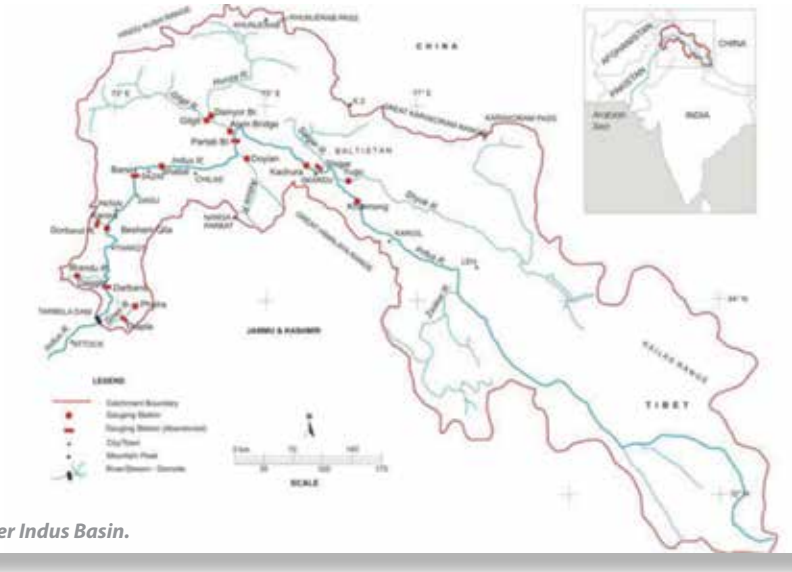

Fig. 14. Upper Indus Basin.

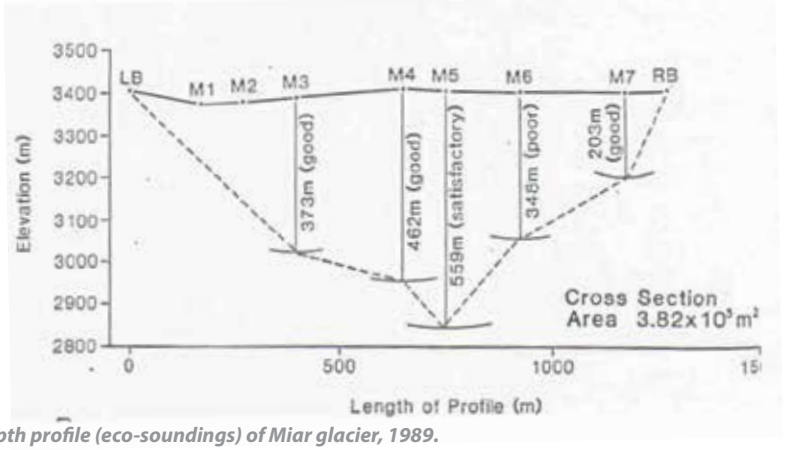

Fig.15. Depth profile (eco-soundings) of Miar glacier, 1989.

and UK Universities on its Pakistan Snow and Ice Hydrology Project Phase-I. Mass Balance of selected glaciers of Karakorum and Himalayas were carried out. Avalanche studies in Kunhar Basin, including hydrology of avalanches, were also carried out.

Ken Hewitt, with WAPDA Staff, studied potential Glacial Lakes sites in the Upper Indus Basin. During 1989 Dr. Gordon Young carried out sedimentation studies of Batura and Passu Glaciers, Central Hunza, with the students of the University of Manchester and WAPDA staff. The ablation gradient of Passu glacier for years 1988 and 1989 was also studied during this period. Some outcomes of studies delivered within the framework of WAPDA activity may be sketched. The bulk of all UIB precipitation occurs in an altitudinal zone of 2500 – 6000 m elevation. The elevation of maximum precipitation is about 5000m in the Western Karakorums and 6000m in Eastern Karakorum.

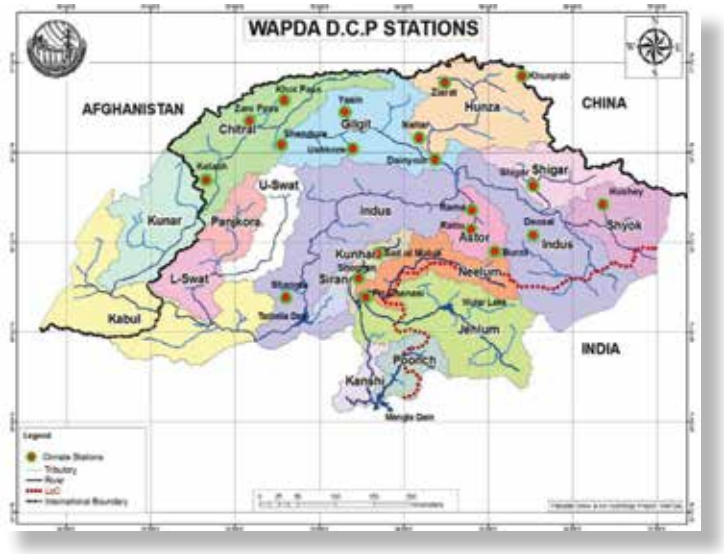

Fig. 16. WAPDA network of stations, Upper Indus Basin.

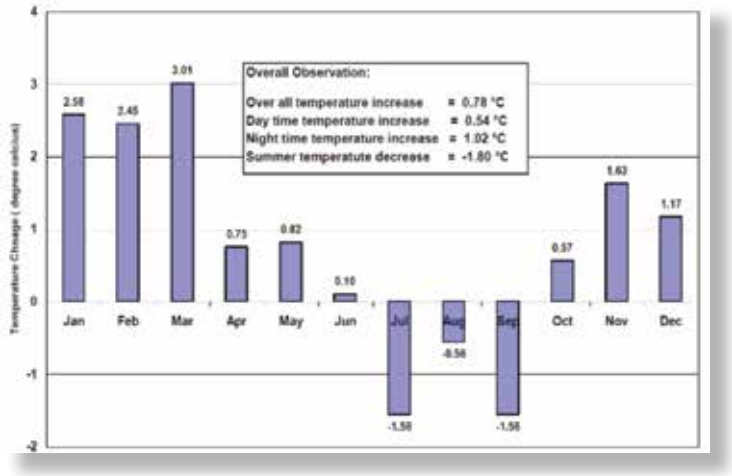

Fig. 17. Temperature change at WAPDA Weather Station Khunjerab (4710 masl) during1995- 2010.

Precipitation is in the order of 1000 – 1800 mm of Snow Water Equivalent.

Most of the UIB glaciers are fed by snow avalanching and the Debris Covered Active melting zone of glaciers is between 3500 to 4800 m asl. Based on the findings of 1985-1989, another Phase - I second phase of PSIHI was initiated in 1991, continuing until 1997.

In this phase, 20 High Altitude weather stations in the elevation zone of 2200 to 4800 m asl were installed in the Upper Indus Basin.

The data from these stations have been collected and transmitted to Lahore Forecasting Centre through Meteorburst Communication System since 1993. A hydrological Model from the University of British Columbia Vancouver, Canada, was obtained and calibrated for the hydrological conditions of the Upper Indus Basin. The UBC Watershed model

has been used for developing and issuing flow forecasts to the Water Managers of the country since 2004. In this operational phase, Seasonal (Kharif and Rabi) and Short Term (10-Daily) flow forecasts of River Indus at Tarbela Reservoir, River Jhelum at Mangla Reservoir and River Kabul at Nowshera, are prepared and issued.

The forecasts are used by IRSA and the WAPDA Authority for the water management of Indus River System and optimum production of hydropower.

Several studies concerning climate change were carried out at WAPDA. In collaboration with the University of Colorado, Boulder, USA, WAPDA studied the impact on the flows of the Indus due to climate change 1991.

Dr. James Wescoat was the Principal investigator in this study.

The UBC Watershed Model was used to generate future flow scenarios.

This study using GCMs from the Goddard Institute of Space Sciences (GISS) and Geophysical Fluid Dynamics Lab (GFDL) predicted a 3.2°C and 4.7°C increase in temperature, respectively, by doubling CO_2 from 1991.

The level shows change in total annual river inflows by 11% to 16%.

Objectives of future activity of WAPDA cover a number of items.

A Glacier Monitoring and Research Centre (GMRC) has been established within WAPDA. WAPDA wants to Conduct Mass Balance Studies of 5 Major Upper Indus Basin (UIB) glaciers, and Monitoring and Mapping of 52.

Large and Medium size UIB Glaciers will be studied for Snout Movement.

Further objectives cover forecasting of Future Water Availability from UIB using Remote Sensing, GIS, Digital Elevation and Glacier Melt Models using different Climate Scenarios, installation of 6 New High Altitude Automatic Meteorological Stations in the Upper Indus Basin, and setting up of a Remote Sensing and GIS Lab in GMRC Lahore.

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Extreme Precipitation, Floods in Pakistan Risk Assessment

1 - Introduction to the session

(**D. Bocchiola,** *Department of Civil and Environmental Engineering, Milan Polytechnic - Italy; Ev-K2-CNR -Italy)*

Mountain regions worldwide undergo every year more and more extreme hydrogeological events (Barnett et al., 2005; Bates et al., 2008). Floods, landslides, glacial outbursts carry tremendous threats to life and economic damages. During the last decade of the past century floods killed more than 100.000 people, and effected 1.5 billion people worldwide, and statistics display significantly higher number of casualties in Asia than anywhere else. This is particularly true within the Hindu-Kush, Karakorum and Himalaya. According to recent studies, flash floods and related hazards occur with increasing frequency within the HKKH (Khan et al., 2011; ICIMOD, 201). The physiographic environment of HKKH, featuring some of the highest mountains in the world, is especially prone to hydrogeological disasters, such as flash floods, landslides, and GLOFs. Recent intensification of de-glaciation as per the observed climate change has enhanced summer snow and ice melting, and has also led to the formation of pro-glacial and epiglacial ponds and lakes, which are in turn prone to glacial lake outburst floods (GLOFs), when the debris/ice formed dams collapse. The Karakorum range is covered in ice to a share of 50% or more, thus GLOFs must be explicitly dealt with, also in relation to their hydrogeological implications, i.e. formation of pulse floods, carrying tremendous high flow discharges downstream. The Karakorum region is known as one of the most amenable to GLOF events: within the last two centuries ca. forty catastrophic GLOF events have been mapped (e.g. Hewitt, 1982), and several potentially dangerous glacier lakes have been mapped recently (e.g. ICIMOD, 2010). To tackle this issue, UNDP has launched

a project aimed to reduce risks and vulnerabilities from GLOFs in Northern Pakistan.
Main objectives are to develop human and technical capacities of public institutions to understand and address immediate GLOF risks for vulnerable communities in Northern Pakistan, and to enable vulnerable local communities to better understand and respond to GLOF. In this session, we illustrate recent activities dealing with the issue of increasing risk of extreme events in the Karakorum. Dr. Gaetani of the GEO group reports GEO activities in natural disaster mitigation, and potential perspectives from the Karakorum. Dr. Calligaris from the University of Trieste and her co-authors provide results from a recent project aimed at mapping landslides in the Karakorum. Dr. Ullah from UNDP Pakistan reports practices for managing GLOF risk in the Karakorum area.

2 - Natural Disaster Mitigation and Earth observations (EO): a GEO perspective.

(**F. Gaetani** - *Group on Earth Observations (GEO) Secretariat)*

Created in 2005, to develop a coordinated and sustained Global Earth Observation System of Systems (GEOSS), to enhance decision making in nine Societal Benefit Areas (SBAs). GEO today has 90 member countries, and 67 participating organizations.

GEO objectives are:

- ➤Improve and Coordinate (existing) Observing Systems
- ➤Provide Easier & More Open Data Access
- ➤Foster Use (ST Applications)
- ➤Build Capacity for the use of EO data

GEO Ecosystems SBA has as a leading theme the changing ecosystems, from Earth Observations,monitoring and research to open data, knowledge dissemination and societal benefits.

Focus is on:

- ➤Ecosystem health, function, and change
- ➤Temporal dynamics
- ➤ Biotic/abiotic interactions
- ➤ Climate and environmental change

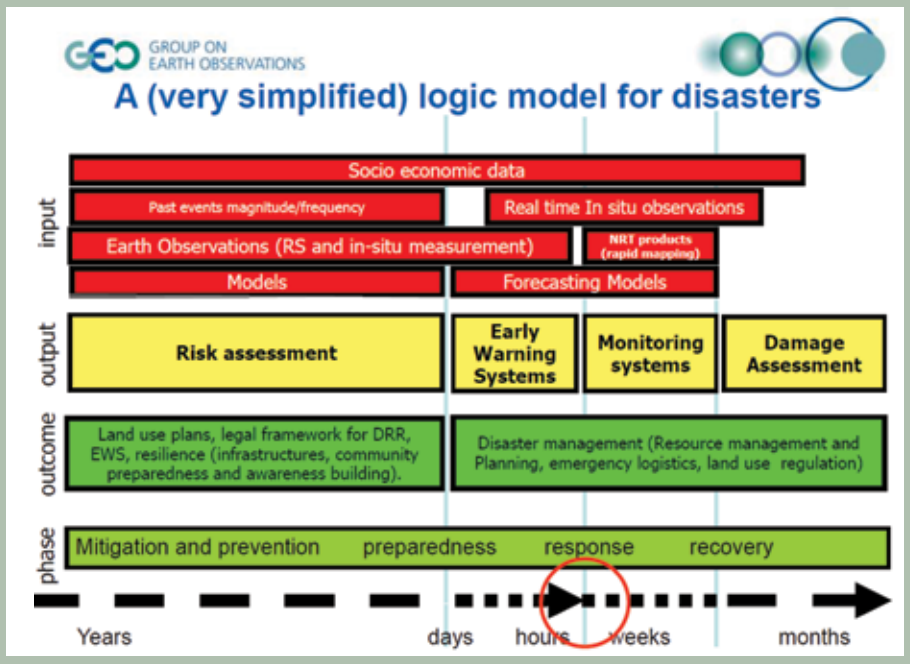
In addition to data, GEO SBA provide analysis tools, and empirical models.

GEO SBA has two components:

EC-01-C1 - Global Standardized Ecosystem Classification, Map and Inventory
(PoC: R. Sayre, USGS)
Standardized global ecosystem maps available for terrestrial, freshwater, and marine environments at 250 m.
Standardized continental terrestrial ecosystem maps at 30 or 90 m available for North America, Central America, South America, Africa, Europe, Australia and China.

GEO SBA has two components:

EC-01-C2 - Operational Monitoring of Key Ecosystems and Related Services
(PoC: AP, ISAC-CNR)
Data and information organized in terms of ecosystem types, focus on protected areas.
Access to data and models on the state, functions, processes and services for keyecosystem types (including mountains and cold-region ecosystems). Response of key ecosystems to climate and environmental change and related changes in ecosystemservices. Response of ecosystems to environmental change and on projections of ecosystem functions and services to future climate and environmental change scenarios. Activities will be conducted in collaboration with national projects such as the Italian project NextData and with international initiatives and programmes, such as ABCC, SHARE and specific EU projects.



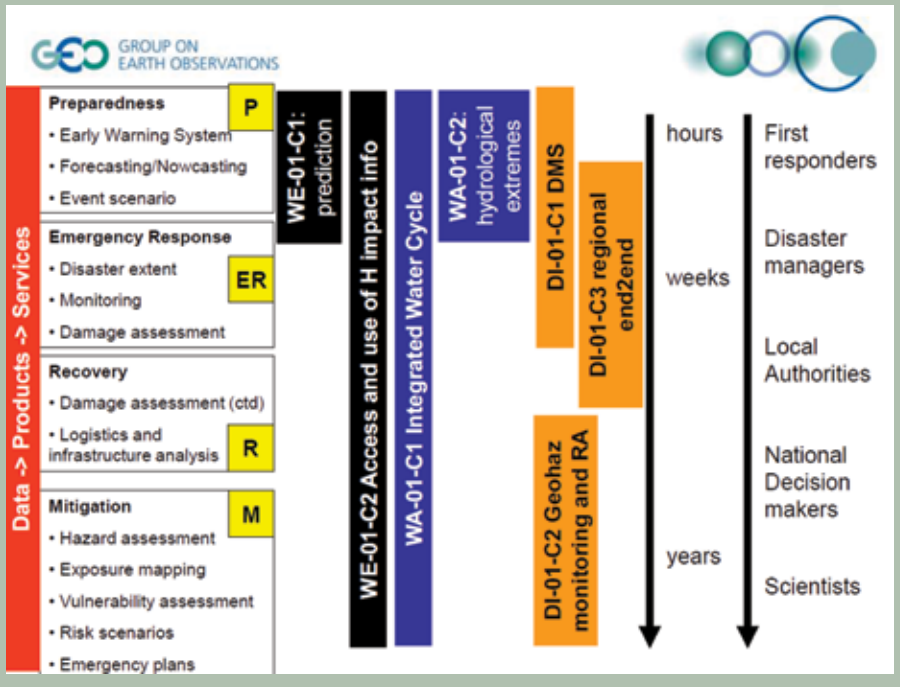


Fig. 1. A simplified logic model for disasters

GEO Regional stakeholders:

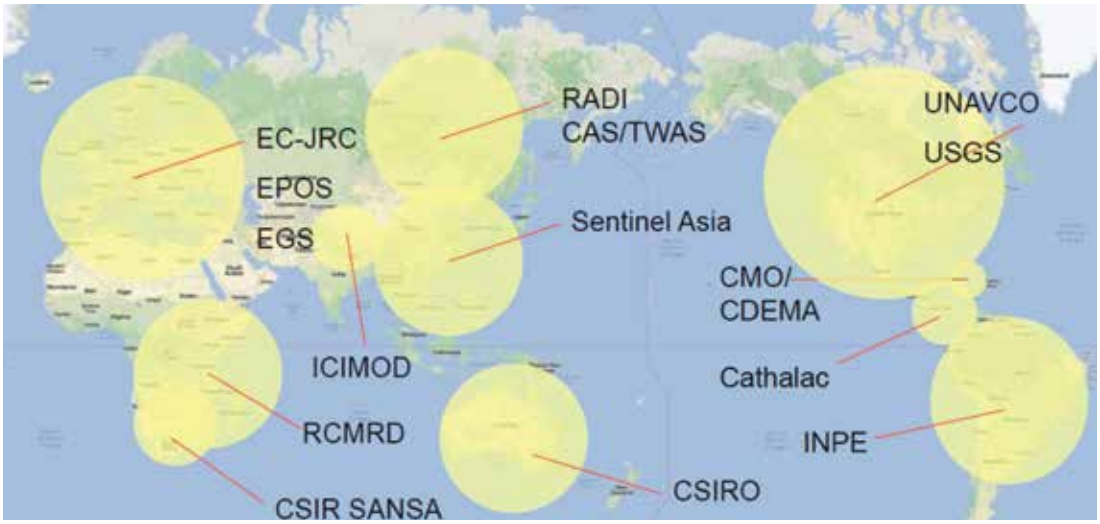


Fig. 2. GEO regional Stakeholders.

GEO Work Plan 2012-2015 DI-01-C3.
The CEOS ad hoc Disaster Team created three thematic teams to develop three thematic pilots (one each relating to floods, seismic hazards and volcanoes) and the related components of the CEOS DRM Observation Strategy.

The pilots will:

- Acquire data
- Gather in situ data if relevant
- Supply data to Thematic value adders (VA) and/or Users
- Supply Thematic value-adding products to Users
- Gather feedback, validation reports, and exploitation reports
- Assess performance and define service roll out

GEO is implementing:

- Southern African Flood and Health Pilot (SAFHP)
- Caribbean Satellite Disasters Pilot (CSDP)

The objectives of these initiatives are to demonstrate the effectiveness of satellite imagery to strengthen regional, national and community level capacity for mitigation, management and coordinated response to natural hazards.
To identify specific satellite-based products that can be used for disaster mitigation and response on a regional level. To identify capacity building activities that will increase the ability of the region to integrate satellite-based information into disaster management initiatives.

GEO Work Plan 2012-2015 WA-01-C1.
GEO is developing a Water Cycle Integrator (WCI), which integrates Earth observations, modelling, data and information, management systems and education systems into a virtual "work bench" for scientific collaboration. GEO has established the Asian Water Cycle Initiative (AWCI) and African Water Cycle Coordination Initiative (AfWCCI) In Latin America, GEOSS water capacity building programmes are now on-going through CIEHYC ("Comunidad para la informacion espacial e hidrografia en Latino America y el Caribe"). Through regional, inter-di-

sciplinary, multi-sectoral integration and interagency coordination, GEOSS/WCI is now leading to effective actions and public awareness in support of water security and sustainable development.

GEO Work Plan 2012-2015 WA-01-C2.
GEO activity under this task covers

• Information Systems for Hydro-meteorological Extremes (incl. Floods and Droughts)
• Development of a Global Flood Awareness System (GloFAS) a joint effort of JRC and ECMWF, aimed at providing early warnings for large transnational river flooding at the global scale.
• Development of a Global Drought Information System that will integrate global, continental, and regional scale monitoring and forecast information with high enough accuracy to assist in early warning efforts.

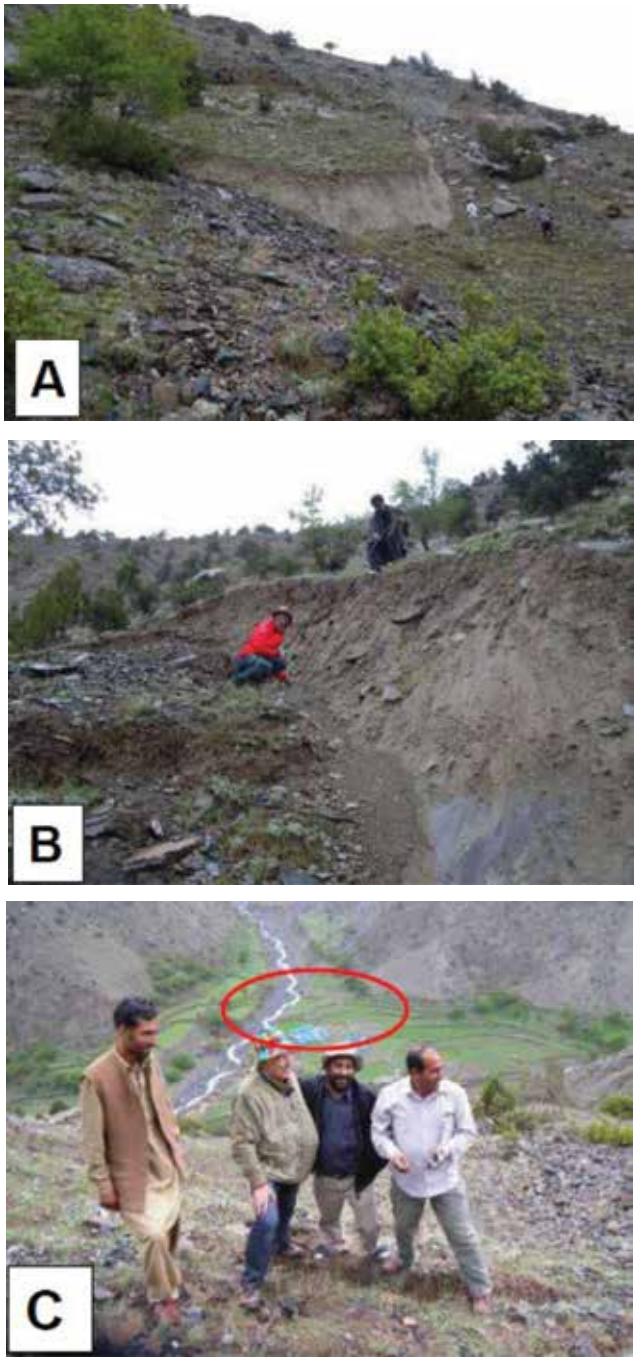
GEO Work Plan 2012-2015 DI-01-C1.
International Charter Space and Major Disasters. In response to a request from the Group on Earth Observation (GEO) to improve access to the Charter during emergencies, collaboration has started with primary focus on users from Africa. Starting in 2009 the Charter has initiated a formal user consultation to address how to improve Charter access. Furthermore, starting from GEO member states of the Asia Pacific region, the Charter was established a link to Sentinel Asia users. Finally in September 2012, the process for the implementation of Universal Access for the Charter has been adopted by the Board. The SERVIR (The Regional Visualization and Monitoring System) covers in Central America 9 countries, in Africa 18 countries, in Himalaya 6 countries, with the aim of supporting in Extreme Events and Capacity Building in the Use of GIS and Remote Sensing for Disaster Management.
GDACS Global Disasters Alert and Coordination System is a cooperation framework between the United Nations (UNOSAT, UNOCHA), the European Commission (JRC) and disaster managers worldwide to improve alerts, information exchange and coordination in the first phase after major sudden-onset disasters.
Global Wildland Fire Information System includes AFIS, a regional fire danger system for southern Africa, an European Forest Fire Information System (EFFIS), a Global Early Warning System for Wildland Fire (Global EWS), and Global Fire Information Management System (GFIMS).
The South African Risk and Vulnerability Atlas (SARVA) is aimed at equipping decision-makers with information on the impact and risk associated with global change in the region.
PREVIEW Global Risk Data Platform is a two-agency (UNEP, UNISDR) effort to share spatial data information on global risk from natural hazards. It was developed as a support to the Global Assessment Report on Disaster Risk Reduction (GAR). *GEM Global Earthquake Model* is about uniform open standards, datasets and tools for worldwide risk assessment. GEM is constructing a global framework (of data, methods and tools), that will enhance risk assessment on local scales and worldwide collaboration. It is a collaborative effort that leverages the knowledge, networks and data of all those who want to partaker of it.

GEO Work Plan 2012-2015 DI-01-C2.
Geohazard Supersites and Natural Laboratories (GSNL). Pooling Satellite imagery and terrestrial in-situ data for earthquake and volcano studies. There are 3 different level of sites, namely I) Permanent Supersite where integration between in-situ and satellite data is promoted by implementing e-infrastructures, II) Post-Event Scientific Forum Supersite web portal, to collect information, data, modeling results etc.. immediately after a catastrophic event, and III) Natural Laboratories Global Network of regional Natural Laboratories.

Challenges and Issues

The current focus is more on global than regional/local issues. Engaging local disaster managers and responders is a major challenge (What are the real user needs? How to provide the right and useful information down to the end users?). One needs to improve disaster management by fostering additional multi-hazard approaches. Data infrastructures (data repositories, data processing, data distribution) are often not accessible for stakeholders and disaster managers of developing countries (technological divide). Future work will need to tackle such issues.

Fig. 3.Khaltaro landslide. A and B main scarp. C. Researchers on the main body of the landslide. In the background the blue tents of the Civil Defence department.



3 - Risk assessment through landslide susceptibility map

(C. Calligaris[1], G. Poretti[1-2], S.Tariq[3], and H. Khan[4]

1 Department of Mathematics and Geosciences, University of Trieste - Italy
2 Ev-K2-CNR – Italy
3 COMSATS Institute of Information Technology - Pakistan
4 Karakorum International University KIU - Pakistan)

The presentation aims to identify the landslide-prone areas inside the borders of the Central Karakorum National Park (CKNP), in order to a have a first landslide inventory in the area.

A qualitative risk assessment is possible where a detailed landslide inventory map and a map of structures (houses, buildings, etc.) and infrastructure (roads, railways, lifelines, etc.) at risk are available in GIS form.

The presentation reports findings of the SEED project in the CKNP area, exploiting the approach of the Italian IFFI project for an Italian landslide inventory.

The Khaltaro landslide

The Khaltaro landslide (Fig. 3) is a sliding

movement of detritic material over a rocky dipping surface.

The length of the crown is approximately 200 m, the height of the main scarp is about 4 m (Fig. 3 A and B), and all around the crown there are tension cracks 1.5 m wide. Walking on the main body (Fig. 3 C), it is possible to identify several longitudinal tension cracks with a gap of 10 to 15cm. This landslide is of particular importance because there is a village with houses and fields at the toe of the slope, on the right side of the river.

The phenomenon is now settling. Witnesses reported that the movement began in 2009. Now, the Pakistani government has put up some tents (red circle) in a safer place (C), close to the village, in order to avoid a possible disaster. Fig. 3C shows researchers on the main body of the landslide, while in the background the blue tents belonging to the Civil Defence can be seen.

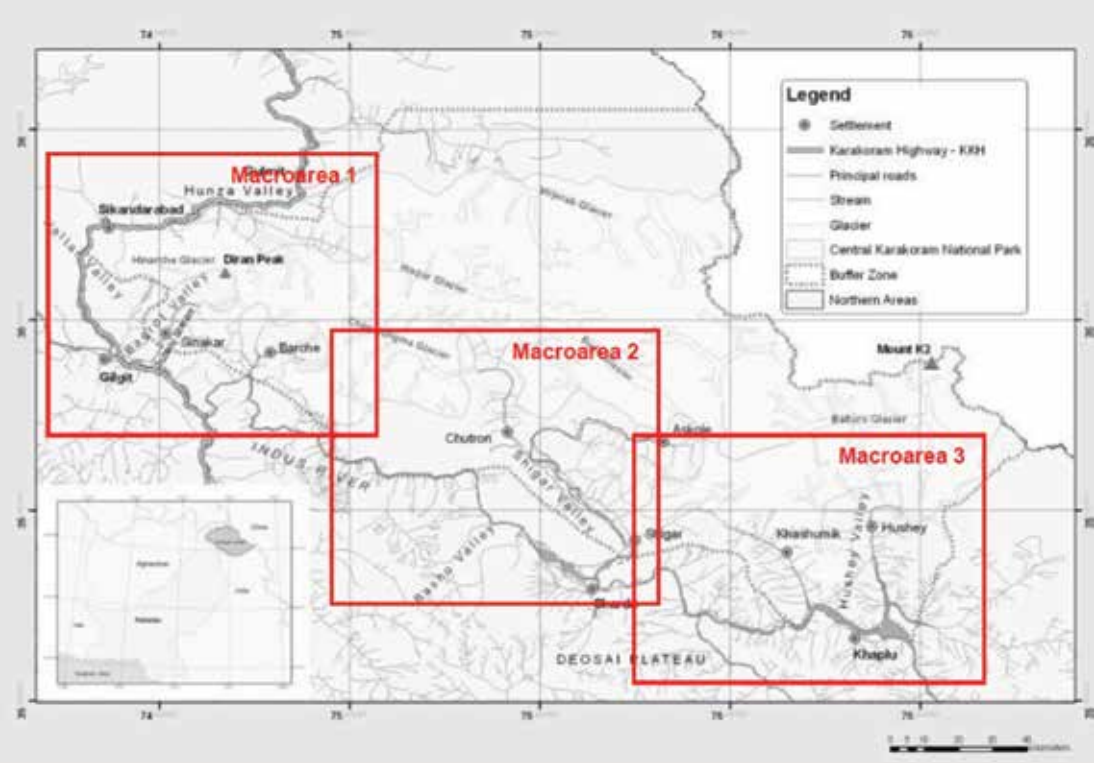


Fig. 4. Area of interest in CKNP.

Results of the SEED project.
To date, after the surveys undertaken in 2011 and 2012, more than 100 landslides have been recognized in the CKNP.

For every landslide, a report was made concerning all the morphological, geological and geotechnical parameters available. Some examples are shown in the Figures below.

Fig. 5. Landslide in Bagrot valley.

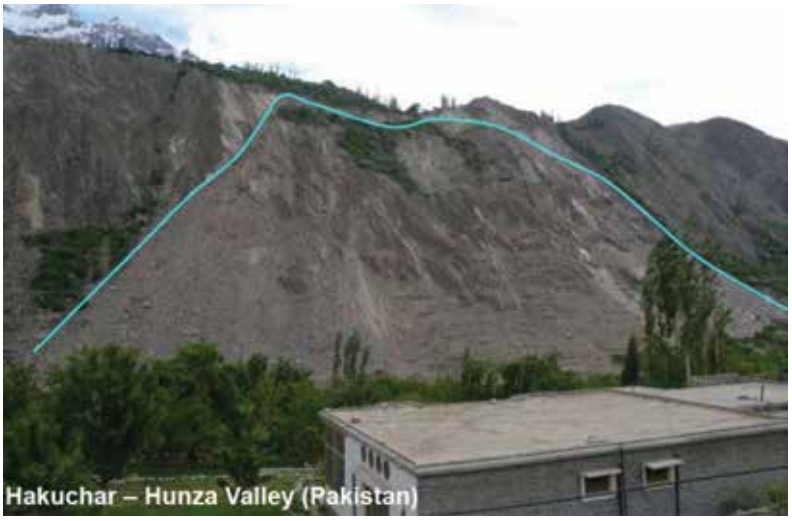


Fig. 6. Landslide in Hunza valley.

As an example, the Upper Nagar village (Figure 7) is protected from the Hunza river by a ridge of about 4400 m. This situation allowed the inhabitants to establish a pleasant, quiet village.
At the end of the village, on the way to Hopar, a landslide overhangs the cultivated fields and the houses.
This landslide is in moraine material and is due to the steep slopes.
To stabilize it, it will be necessary to reshape the entire slope with terraces. This will also allow the cultivation of more fields, as well as improving the hydrogeological control of the area. Drainage will be recommended.

Fig. 7. Landslide in Hunza valley.

In the Figures from 8 to 10, a case study is reported of landslide risk mapping for the Bagrot valley.

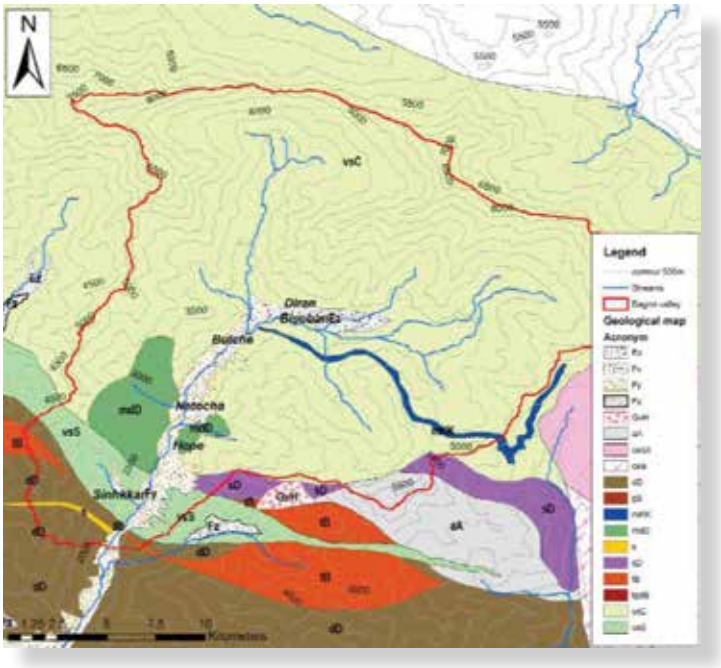


Fig. 8. Geological map of Bagrot valley.

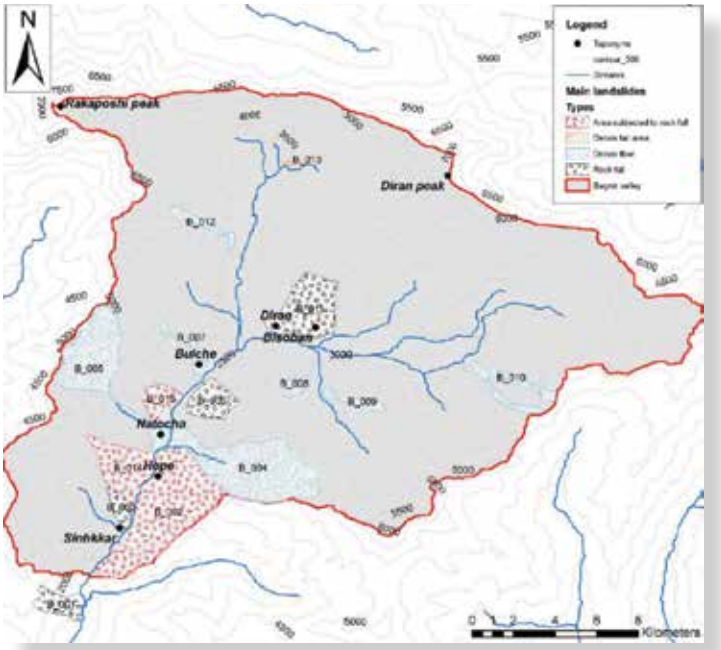


Fig. 9. Landslides classification in Bagrot valley.

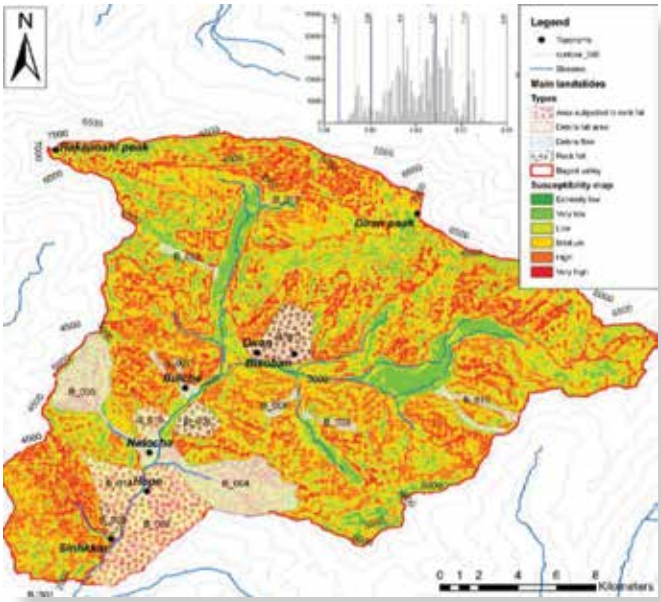


Fig. 10. Landslide susceptibility in Bagrot valley.

Risk assessment analysis was carried out in Bagrot valley by accounting for geology, slope, aspect, curvature, ice, and land cover, according to AHP (Analytic Hierarchy Process) technique and PAIR-WISE comparison matrix (Saaty, 1998; Tab.1). Factors and classes with the assigned relative ranks range from 1 to 9 in order of importance. Weights (0-9) were assigned to the classes: higher values indicate greater susceptibility to landslide occurrence. Landslide risk evaluation aims to determine the "expected degree of loss due to a landslide (specific risk) and the expected number of lives lost, people injured, damage to property and disruption of economic activity (total risk)".

To define risk it is necessary to identify the elements that are most exposed. In the CKNP case, they are mainly represented by routes, taking tourists to the park and peaks therein.

Therefore, the scientists' attention is focused on these frequented areas. Joint data will form the basic risk map on which decision makers could start work.

Tab. 1. Analytic Hierarchy Process technique and PAIR-WISE comparison matrix.

Factors	Classes	Ranks	Weights
Geology	Paragnelsess(SKm)	1	4
	Andesite (Cv)		6
	Slates (Gm)		9
	Gabbrodlorite (KB)		6
	Permanent snow/ice cover		1
			6
Fault butter	0-250m	1	6
	250-500m		3
	500-750m		0
	> 750		1
Slope	0°-15°	2	3
	25° - 35°		5
	35°- 45°		7
	> 45°		9
Aspect	Flat	1	0
	North		1
	Northeast		4
	East		7
	Southeast		8
	South		9
	Southwest		6
	West		3
	Northwest		2

In summary, resume, the result of landslides mapping activity within the SEED project were as follows

- ➤ Three valleys were surveyed in 2011, and 2 in 2012: Bagrot, Haramosh, Hopar, Chogolungma and Biafo and more than 100 main landslides were identified
- ➤ Data concerning lithological characteristics, land cover, tectonics, land use and glacier extension were collected
- ➤ The identified landslides were catalogued, and the main characteristics were defined
- ➤ A simple but complete landslide identification form was created and field tested
- ➤ A GeoDataBase was implemented
- ➤ A preliminary GIS investigation was undertaken
- ➤ Jointly with the GIS group, preliminary geological and tectonic maps of the CKNP area were prepared, starting from a 1:650.000 and 1:150.000 scale studies

A susceptibility map was produced.

Further work will be necessary to validate the susceptibility maps against ground data, and remote sensing information.

4 - Managing GLOF in the Karakorum-Hindukush region through grafting indigenous and scientific management practices

*(**S. Ullah** - Environment and Climate Change Unit, UNDP)*

Pakistan is one of the countries suffering most from climate change and one of the worst examples of climate injustice. The Maplecroft vulnerability index places Pakistan in the High/Extreme category, and Germanwatch places Pakistan as "Most affected" for 2010 and among the "TOP 10" for 1990-2010.

Melt flows of major river systems during the summer months have increased to more than double their amount over the past 10 years. Glacial retreat is evident from the base of the affected glaciers and continuous thinning of ice along their entire length.

The area is annually affected by a number of climate-related GLOFs. These include floods, avalanches, and landslides, with loss of human lives and property. Local impacts of GLOFs are devastating and often go unreported. GLOFs are considered as a national challenge in the Planning Commission Task Force reports, and National Climate Change Policy.

Tab. 2. Potentially dangerous glacial lakes in the Indus River Basin.

RIVER	GLACIERS			GLACIAL LAKES		
	N.	Area [km²]	Ice reserve [km³]	N.	Area [km²]	Potentially dangerous
Swat	233	224	12	255	16	2
Chitral	542	1904	259	187	9	1
Gilgit	585	968	83	614	39	8
Hunza	1050	4677	809	110	3	1
Shigar	194	2240	581	54	1	0
Shyok	372	3547	892	66	3	6
Indus	1098	688	46	574	26	15
Shingo	172	37	1	238	12	5
Astor	588	607	48	126	6	9
Jhelum	384	148	7	196	12	5
Tot	**5218**	**15040**	**2739**	**126**	**126**	**52**

The project Goal of the commission is 'To enhance adaptive capacity to prevent climate change-induced GLOF disasters in Pakistan.

Specific objectives are :

1. To develop the human and technical capacity of public institutions to understand and address immediate GLOF risks for vulnerable communities in Northern Pakistan
2. To enable vulnerable local communities in Northern Pakistan to better understand and respond to GLOF risks and thereby adapt to growing climate change pressures

The project's outcomes are:

1. Policy Recommendations & Institutional Strengthening
2. Strengthening Knowledge and Information about GLOF
3. Demonstration of Community-Based GLOF Risk Management
4. Documentation, Analysis and Application of Lessons Learnt

Major activities of the project cover:

- ➤ Inventory update through GIS & Remote Sensing and ground-truthing by PMD and development of SOPs for early warning systems (EWS)
- ➤ Strengthening of indigenous Early warning system
- ➤ Hazard and Vulnerability risk Assessment
- ➤ KAP Studies
- ➤ Study on Social Economic Impact of GLOF
- ➤ Assessment of impact of GLOF on Biodiversity
- ➤ Development of a GLOF Risk management Manual and DRM Trainings
- ➤ Google & Hazard Mapping
- ➤ International Conference on GLOF
- ➤ Communication & awareness
- ➤ GLOF DRM Associations
- ➤ GLOF Hazard Watch Groups
- ➤ GLOF DRM Fund
- ➤ Adaptation (Bio-engineering) structures
- ➤ Automated Weather Station & Early Warning system
- ➤ Safe Havens articulation
- ➤ GLOF Disaster Emergency Response Cell

The project location sites are the Bagrot valley (see Figure 8 above), and the Drongagh valley (Figure 11).
Bagrot Valley in Gilgit-Baltistan is considered at high risk of GLOF from the Bagrot Glacier. Bagrot comprises 1100 households, a population of 10,000 and lies at 40 km from Gilgit town. Bindo Gol valley (Drongagh) in Chitral is located in the vicinity of Gohkir and Bindogol Glaciers. It comprises 1500 households with a population of almost 13,500, and lies approximately 65 km away from Chitral municipality.

Fig. 11. Topographic map of Drongagh area, Chitral district.

Table 3 reports a comparison between traditional and scientific knowledge in use. Figure 12 displays an example of bio-engineering structures, which allow risk containment at relatively low cost and environmental impact.

Tab. 3

STREAMS OF KNOWLEDGE	
Indigenous Knowledge	**Scientific Knowledge**
Lengthy acquisition	Rapid acquisition
Long-term wisdom	Short-term prediction
Powerful prediction in local areas	Powerful predictability in natural principles
Weak in predictive principles in distant areas	Weak in local areas of knowledge
Models based on cycles	Explanations based on hypotheses, theories, laws
Classification: • a mix of ecological and use • non-hierarchical differentiation • includes everything natural and Supernatural	Classification: • based on phylogenic relationships • hierarchical differentiation • excludes the supernatural
INTERVENTIONS THAT INTEGRATE BOTH TYPES OF KNOWLEDGE **Hazard and Vulnerability risk Assessment**	
•Observations such as the springs drying-up as the source does not receive water which is stored in the lake due to landslip/landslide; • Water shortage at household level which indicates that the discharging holes are obstructed, pressure is mounting **Local knowledge indicates the mounted hazard**	•Hazard mapping done by using satellite images, followed by Ground Truthing and the Ground Penetrating Radar GPR **Hazard is scientifically investigated**
AUTOMATED WEATHER STATION AND EARLY WARNING SYSTEM	
• To warn the communities the shepherds smoke on the tops, now done with the help of loudspeakers, albeit on observations by local communities; • Strengthening of indigenous Early warning system (LOA with community is signed)	• Early Warning System devised by the PMD based on prevailing technologies installed. • Community is trained in the use of this system
THE TRAINED COMMUNITY ALREADY HAD INDIGENOUS KNOWLEDGE, SO IT IS NOW EQUIPPED WITH BOTH THE STREAMS **Structural measures**	
• Biological measures such as planting various species with anchorage and productivity capacity. • Improvised low cost, lighter structures, maintained locally.	• Engineering structures, heavy in size and cost. • Biological measures with exotic species but done in parallel.
Bio-engineering structures that integrate all biological measures with locally suitable engineering measures	

Fig. 12. Example of bioengineering structure for landslide containment.

In conclusion, one counts upon the scientific knowledge of other organizations at least in the beginning.
As represented here, grafting of both streams of knowledge works well, although it requires systematic analysis and needs to be part of the overall knowledge management process.
Integrating indigenous and scientific knowledge leads to sustainability in terms of ownership, continuity, and cost containment.
The tacit knowledge that is endangered will not be lost once it is converted into implicit knowledge and translated into grafted practices.

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CLIMATE CHANGE: Environmental Impact, Resource Management and Mitigation Actions

1 - Introduction to the session

*(**A.Bocci**, Department of Life Sciences, University of Siena - Italy; Ev-K2-CNR – Italy)*

Climate change refers to any significant change in the parameters of climate, lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among other effects, that occur over several decades or longer. Rising global temperatures (*global warming*) have been accompanied by changes in weather and climate: many places have seen changes in rainfall, resulting in more floods, droughts, or intense rain, as well as more frequent and severe heat waves; the planet's oceans and glaciers have also experienced some big changes. Climate change involves complex interactions between climatic, environmental, economic, political, institutional, social, and technological processes. Thus, it cannot be addressed or understood in isolation.

There are two main approaches to deal with climate change:

- climate mitigation, i.e. any action taken to permanently eliminate or reduce the long-term risk and hazards of climate change (e.g. reducing GHG emissions).
- climate adaptation, i.e. the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damage, to take advantage of opportunities, or to cope with consequences. The adaptive capacity is in fact the potential to adjust in order to minimize a negative impact and maximize benefits from any change in climate. A successful adaptation can reduce vulnerability by building on and strengthening existing coping strategies. While mitigation is concerned with the causes of climate change, adaptation deals with the effects of the phenomenon.

2 - Climate change in Pakistan

(**Q. Chaudry** - *Climate Affairs, Government of Pakistan)*

In Pakistan, a considerable increase in frequency and intensity of extreme weather events, like erratic monsoon rains causing frequent and intense floods and drought, has been recorded as a consequence of climate change. All the threats related to climate change (e.g. reduced agricultural productivity due to increased temperatures or increased intrusion of saline water into the Indus delta due to sea-level rise) may lead Pakistan to major concerns in terms of water, food and energy security, even if its contribution to global GHG emissions is 0.8% and ranked 135th on a *per capita* basis. The key sectors for adaptation to climate change are the main natural resources (water, forestry and wildlife) as well as human health and activities (agriculture and livestock).

The most vulnerable ecosystems are mountainous areas (as CKNP), arid areas, wetlands, and coastal/marine ecosystems

KEY SECTOR		POLICY MEASURE
water resources	Water Conservation Strategies	•conservation, reduction in irrigation losses and use of efficient irrigation techniques •Local rain harvesting measures
	Water Management	•Increase of water storage capacity and identification of new dam sites •Protection of surface and ground water degradation •Recycling of waste water •Protection of catchments and reservoirs •Rational ground water exploitation
	Enhancing capacity	•Domestic water saving and sea water utilization •Monitoring temporal changes in glaciers, snow cover, and meteorological parameters •Strengthening river flow monitoring network & flood warning system
agriculture and livestock	Research	•Develop digital simulation models for assessment of climate change impacts on physical, chemical, biological and financial aspects of agricultural production systems in various agro-ecological zones • Develop new varieties of crops which are high yielding, resistant to heat stress, drought tolerant, less vulnerable to insects and pests
	Technology	•Energy efficient farm mechanization •Adopting laser land leveling, optimized planting dates, crop diversification •Incentives for water saving technologies •Bio-technology for improved crops & livestock breeds
	Management	•Expansion of cultivated lands through rain harvesting & development of wastelands

Tab. 3. Summary of the main policy measures, for each key sector.

KEY SECTOR		POLICY MEASURE
		•Feed conservation techniques •Remote sensing & GIS techniques to assess land cover changes, water logging, salinity
	Risk Management	•Risk management against crop failures, and extreme weather events •Effective communication of climate information to farmers •Encourage agriculture-drought management practices
forestry and biodiversity	Forest Management	•Explore new planning and decision support tools to deal with uncertainty and risks in long-term forest planning • Ensure flexible adaptive planning that allows the consideration of multiple options • Encourage area specific adaptive practices with greater participation of local communities
	Habitat conservation	
	Community participation	

As for forestry and biodiversity in particular, scientific research on their management is required mostly in key habitats, such as mountain areas, to understand the present situation as well as to assess threats, productivity and changes in species composition.

3 - Central Karakorum National Park

(**A.Bocci**, *Department of Life Sciences, University of Siena - Italy; Ev-K2-CNR – Italy)*

The Central Karakorum National Park is situated in Northern Pakistan, bordering China and India, and it represents one section of the Asian high-mountain system of Hindukush Karakorum-West Himalaya.
The area enjoys a unique natural and cultural heritage that is one of the richest in the world. Unfortunately, external pressures, such as overpopulation, invasive development, pollution, and unchecked exploitation of natural resources, as well as climate change, threaten this heritage.
The first notification of the Central Karakorum National Park (CKNP) was issued in December, 1993, without a zoning system and a related management plan; furthermore, its boundaries showed a significant overlap with the adjacent Kunjerab National Park, previously established in 1975.
Since then, several organizations have developed different drafts of CKNP management plan - planning also the enlargement of the original protected area as in the concept of the Central Karakorum Complex – but none of these documents was approved by the higher institutions, leaving the Park without an operative management tool till now.
EvK2CNR, through the SEED project, used a "participatory approach" to draft the CKNP Management Plan, directly involving the communities in biodiversity conservation, but also suppor-

ting their needs in a sustainable way. Management programmes, incorporating sustainable use of resources, are devised to reduce conflicts between conservation and development, creating long-term income sources from habitats which may otherwise have no economic value and/or may be altered to pursue other forms of revenue. An understanding of ecological and conservational principles as well as reliable ecological data are fundamental requirements for successful conservation and management actions and for a successful zoning of any National Park. As to wildlife in particular, information on population size and distribution of a species is important to assess its status, i.e. declining, stable, or increasing. If numbers of a population are known, its management could be properly addressed.

This action is particularly important for protected areas where several "threatened" species are present and subject to moderate trophy hunting. For the zoning of any Park, large mammal distribution and numbers could be very useful as they may be used as "umbrella species" better than any other *taxon*.

An *umbrella species* is defined as a species with large area requirements, so that its protection offers protection to other species that share the same habitat. Viable populations of large mammals require vast areas of land (as a minimum threshold, herbivores: 10000 ha; carnivores: at least 100000 ha) and all of them can be considered as an umbrella species group for the preservation of plants and others animals. In particular, the requirements of large carnivores should be considered in the final step of a management plan. Therefore, these species are often selected to make conservation related decisions, helping to select the locations of potential reserves, to find the minimum size of these conservation areas and to determine the composition, structure and processes of ecosystems.

At the same time, information on livestock, in particular numbers, management systems (e.g. using the same pastures as wildlife, and, if so, for how long), sanitary status and depredation/disease losses, is also important to properly address management, reducing conflicts and providing economic and employment opportunities to local communities as well as increasing the knowledge of species and ecosystems to enhance conservation.

Before the SEED project started in the CKNP area, basic information on the main natural resources (wildlife, forest, water, glaciers, but also livestock and any other resource) was very scanty and not systematically collected.

With regard to *wildlife*, the status of threatened species inhabiting the Central Karakorum National Park was almost unknown, but some information indicated that numbers of the snow leopard and especially of markhor were very low and close to their biological threshold (Shackleton 1997). Over-hunting, habitat loss and isolation of small populations have probably been the main reasons for this depletion (Shackleton 1997).

Although a "focal approach" and systematic surveys were proposed as a key action in the IUCN Action Plan for *Caprinae* (Shackleton 1997) and in the 1999 draft Management Plan (McDonough 1999), very limited sound information was available on the distribution and numbers of local wildlife (*e.g.* Virk et al. 2003, Roberts 2005). Furthermore, all the information was limited to the border areas of the Park, where human activities are greater and access is easier.

Concerning *birds*, again, only scanty information was available for the area: although presence was recorded, number and distribution of species were still unknown.

As for *livestock*, although it is an important part of the local agricultural economy (it accounts for 51% in agricultural GDP and 11.9% in National GDP), providing milk and meat for consumption and sale, dung as fertilizer and supplying traction for agricultural operations, numbers were available, but not systematically collected throughout the area, while no information was available on pastures that they occupy during the summer.

4 - Data on large mammals

(A. Bocci[1-2], E. Ercoli[1], M.Z. Khan[3], M.A. Nawaz[4] , S. Lovari[1-2]
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4 Snow Leopard Trust - Pakistan)

To properly collect data on wildlife in a short time and in a so huge and remote an area as CKNP, a questionnaire relevant to large mammals in each valley of the CKNP was prepared, distributed and filled in, with the help of the local communities and the support of the Snow Leopard Foundation.

All the information collected was used to draft the *distribution maps* and to fill in a table with *minimum numbers* (Tab.2) for the whole Park area (in general, a conservative approach was adopted, by limiting the local population size estimate to its minimum number).

As far as numbers were concerned, some surveys were also carried out in the main valleys of the Park (Hushey, Askoli, Sikendarabad, Hispar), where ungulates are present, to cross-check data.

The main constraint in drafting the maps and assessment of numbers of large mammals in CKNP is related to the seasonal movements which the animals make and the problem that often neighbouring valleys may share the same population. As to large carnivores, for example, they tend to live in low densities, especially at high altitudes, moving over very wide areas because of dispersion of their main food resources (wild ungulates).

These habits make their conservation particularly difficult because the same individual may visit different valleys, which could upset counts carried out only through sightings or signs of presence.

To reduce this problem, data on the individual distribution of large carnivores in one study site (Hushey valley) were obtained through DNA analyses of scats collected over different valleys with a standardised approach.

Data on abundance could provide a measure of the relative density of herbivores, which could be used to compare the status of subpopulations from different areas and, in future, that of each area in different years.

The Hushey valley was also used as a case study for the *assessment of predation*: preliminary results (N=151 scats; wolf: N=63; snow leopard: N=88) show a greater impact on livestock by wolf (59%; Figure 1) than by snow leopard (43%; Figure 1), during the cold season, when the terrain is covered by snow, while during the warm season the proportion of ibex increases also in the wolf diet.

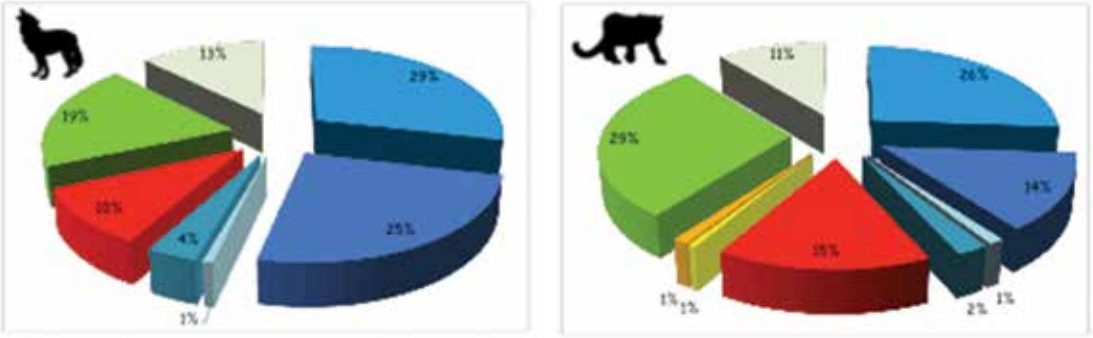

Fig. 1. Percentage of predation of wolf (a) and snow leopard (b) on the main prey.

Tab. 2. Minimum numbers of large mammals in each main valley of CKNP (Data have been cross-checked and, in some cases amended, by comparisons with data recorded by Park rangers and/or own data).*

Valley	Brown bear	Snow leopard	Lynx	Wolf	Markhor	Ladak urial	Marco Polo sheep	Blue sheep	Asiatic ibex	Musk deer
Jaglot/Minapin	0	2	1-2	1	20-40*	0	0	0	100-150*	0
Bagrote	0	5	5	2	<50	0	0	0	100	0
Haramosh	0	5	5	5	>10	0	0	0	100	2-5
Astak-Tormik	0	3	2	2	8-12	0	0	0	40-150*	1-10
Hoper	1	≥2	0	≥2	0	0	0	0	50-300*	0
Hisper	0	≥2	0	0	0	0	0	0	>300*	0
Hushey	0	2	2	2	0	0	0	0	100-500*	0
Thalley	1	1	3	2	0	0	0	0	6-150	0
Braldu	1	2	2	2	0	30	0	0	10-300	2-6
Basha	≤6	1	2	2	0	0	0	0	10-150	2-6
Shigar	0	1	2	2	0	6	0	0	10-150	2-5
Nar	0	3	2	2	0	0	0	0	100*	0

5 - Data on birds

*(**J. Baig**, Karakoram International University,Gilgit-Baltistan)*

The study on birds was conducted in Shigar and Fuljo (Skardu) in July 2012 and Rajabe gonong, Hapakonch and Tagaphari (Minapin, Nagar) in June 2013, to collect and document the inventory of all existing species in the CKNP region, to ascertain threats, and also to suggest management strategies for a sustainable use.

Data was collected through direct visual observations with the help of binoculars, mist-netting, field spotting scopes, audio playbacks and habitat maps.

Twenty-seven bird species in the first area and thirteen in the second were captured, identified and recorded, and some feather samples were procured for future taxonomical and population analyses.

Two new species were recorded: one new to Pakistan's bird fauna (*Otus brucei*) and one to Gilgit Baltistan bird's fauna (*Sylvia mystacea*).

Fig. 2. Palid Scops Owl (Otus Brucei). Fuljo Top, August/7/2012.

6 - Data on livestock

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Different types of livestock are reared in the valleys of CKNP (goat, sheep, horses, donkeys, cattle, yak, yakmo, zo, zomo, bull, mules and poultry) for the purposes of meat, milk, wool and transportation.

The livestock production and sanitary status were studied in 2013 in several valleys: Braldo, Hushey, Khanday, Sikendarabad, Minapin. Baseline information was gathered on pastures, total livestock population, major crops, vegetables and fruits, irrigation system, as well as livestock numbers, type, breeding method, age at first calving, dry period, calving interval, fodder storage method, feeding method, type of shed, milk production, milk marketing and livestock diseases.

The project was initially carried out in some specific valleys, to be then used for further studies or planning, improving livestock production in the area Interactions between domestic animals and wildlife were also studied, in an attempt to assess whether overgrazing by livestock could be a true limiting factor for wild Caprinae within

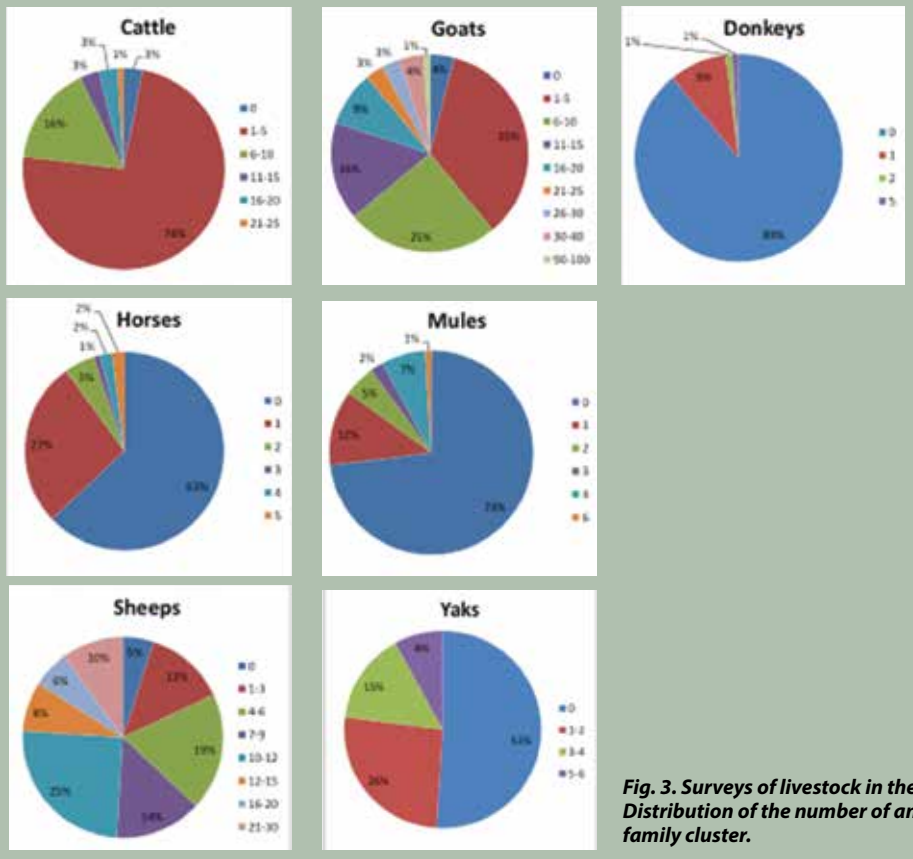

Fig. 3. Surveys of livestock in the CKNP park. Distribution of the number of animals as per family cluster.

CKNP. Livestock diseases are also deemed worthy of study, first for the benefit of free-ranging wildlife in the area. This particular topic is still undergoing data collection.

7 - CKNP Management plan

(F. Mari[1], M. Gallo[1]
1 Ev-K2-CNR - Italy)

Reliable basic data collected in the field were used in March 2013 to draft the 1.1 version of the CKNP Management Plan, where the boundaries and related zoning system of the Park were presented, in connection with the rules for natural resource sustainable use by local communities. Villages, roads, main mining areas and agricultural lands were not included within the Park boundaries, to give to the management plan a greater potential of being immediately applicable in the local context (Fig.4). Fifteen valleys were identified, for a total number of 150 villages, 19,688 households and 151,047 people.

The Park zoning produced two main areas, (*a)* **core area** and (*b*) **buffer zone**; each of them was divided into several other areas, with different rules and restrictions (Fig.5).

Basic data on wildlife, livestock and forests were used for the zoning of the Park.

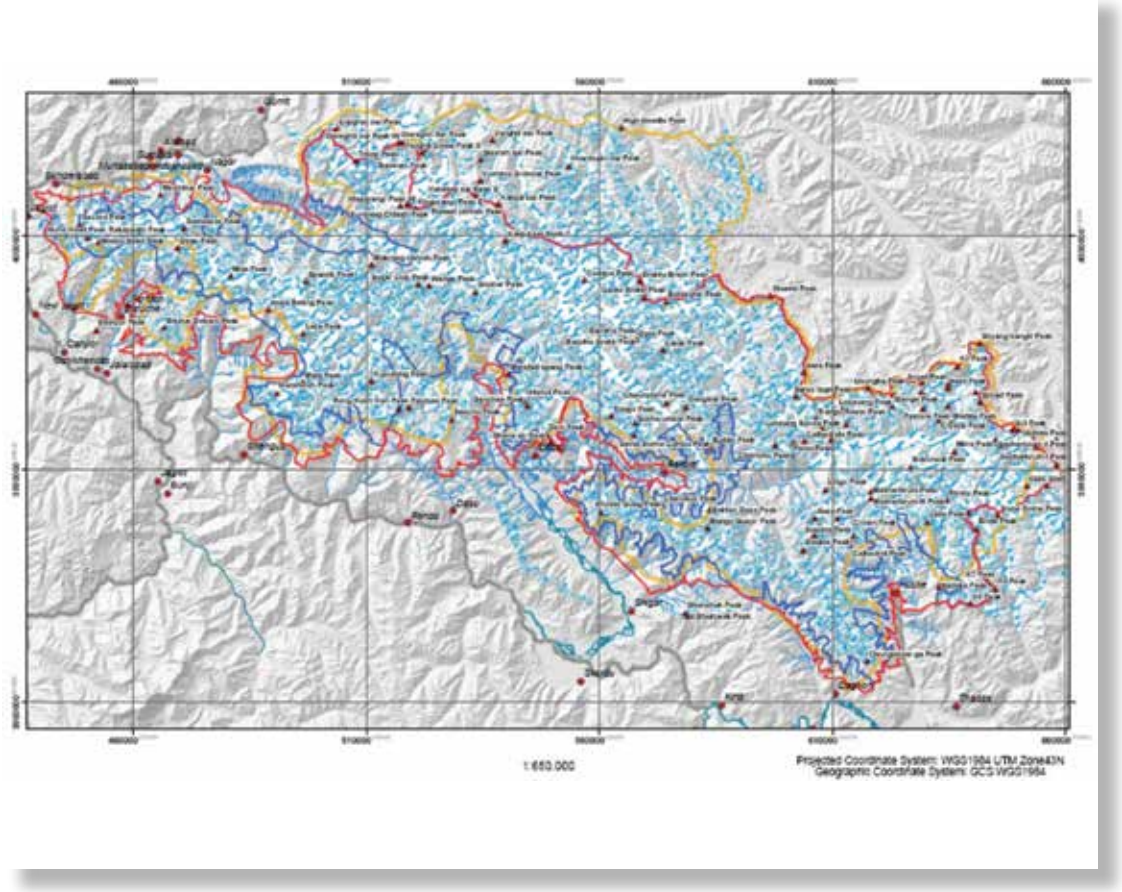

Fig. 4. CKNP boundaries and related zoning system.

*Tab. 3. Summary of management indications. ^ Following specific management indications. * Only upon entrance permission released by CKNP directorate.° In this area the veterinary and vaccination programme for livestock has high priority. °° Accepted only free roaming yak, cow and crossbreed. A specific programme for the presence of these animals needs to be developed with the local communities. * Allowed only in Trango area.*

Summary of the management indication in the CKNP zone system	Local communities, GB people admittance (no fees)	Pakistani, foreigners visitors admittance	Local communities livestock grazing	Presence of pack animals	Presence of dogs	Hunting	Game bird Hunting	Fishing	Firewood collection	Timber extraction	Collection of medical herbs & not timber forest prodcuts
Buffer zone	v	v	v	v	x	x	x	x	v	v	v
Conservation area	v	v	v°	v°	x	x	x	x	v	v	v
Trophy hunting Zone	v	v	v°	v°	x	v	x	x	v	v	v
Corc zone	v	x*	v°°	x	x	x	x	x	x	x	x
Turism focus areas	v	v	x	v	x	x	x	x	x	x	x
Low frequency tourism area	v	v	x	x+	x	x	x	x	x	x	x
Occasional tourism area	v	v	x	x	x	x	x	x	x	x	x
Strictly conservation areas	x*	x*	x	x	x	x	x	x	x	x	x

On the basis of large mammal distribution and numbers, some areas were identified for special protection:

- ***CONSERVATION AREAS*** (in the buffer zone): These areas were identified because a range of endangered large mammals (eg musk deer, markhor, brown bear, snow leopard), and/or forest are present there; thus, some restrictions to human activities (eg. livestock farming, wood collection,...) were imposed, accompanied by some form of compensation, as well as a responsible involvement of the local community in conservation programmes.

- ***COMMUNITY CONTROLLED HUNTING AREAS*** (in the buffer zone): These areas are characterized by a good presence of trophy animals (ungulates) under the protection of national and international agreements. A sustainable and conservation-oriented trophy hunting system may be a valid management tool, increasing the economic revenue of local communities, provided that a reliable monitoring of ungulate populations is carried out to assess their conservation status, plan hunting activities and promote them as a long-term source of income. Trophy hunting represents a conservation measure for the species because of the large income (80%) for the local communities generated by selling license fees for the harvesting of a trophy male, an authorized

- ***STRICTLY CONSERVATION AREAS*** (in the core area): These areas were identified to integrally protect parts of the Park where important and endangered wild species live. Thus, any human activity, other than assessing wildlife numbers through regular seasonal counts or research activities, is forbidden.

Another three areas were assessed on the basis

of tourism activities, related to the sustainable use of resources:

- ***TOURISM FOCUS ZONE*** (in the core area): This area is a corridor of about 250 meters on both sides of the trail that passes through Baltoro, Gondogoro to Hushey. This is the main and most famous route used by trekkers and mountaineers, where campsites and visitor services are available.
- ***LOW FREQUENCY TOURISM AREA*** (in the core area): This area is a network of trekking routes linking different peaks, which are considered in the same group on the basis of their attendance: the routes and peaks are generally seldom or never frequented, but in any case every year they attract a fair number of visitors.
- ***OCCASIONAL TOURISM AREA*** (in the core area): This area is a network of trekking routes and peaks with a low level of attendance recorded in the last few years.

Therefore, the natural presence is becoming more relevant here, almost equal to the Core Zone one, which surrounds these areas.

Subsequently, an evaluation and consultation phase commenced, involving the institutional level as well as the different local communities which have some of their territories within the proposed Park's boundaries. This second phase was particularly important in the way it moved from a general approach to a valley level one, with particular reference to the use of natural resources. In this respect, a use rights map was also drafted.

As to Communities' perception, the main problems arising are related to (*I*) the lack of communication with the CKNP Directorate; (*II*) the statutory laws/customary laws, that should be compatible with environmental conservation and park sustainability, as well as homogeneous among valleys; (*III*) the implementation of incentives; (*IV*) awareness and capacity building on new strategies for natural resource conservation; (*V*) the need of large funds for infrastructural projects.

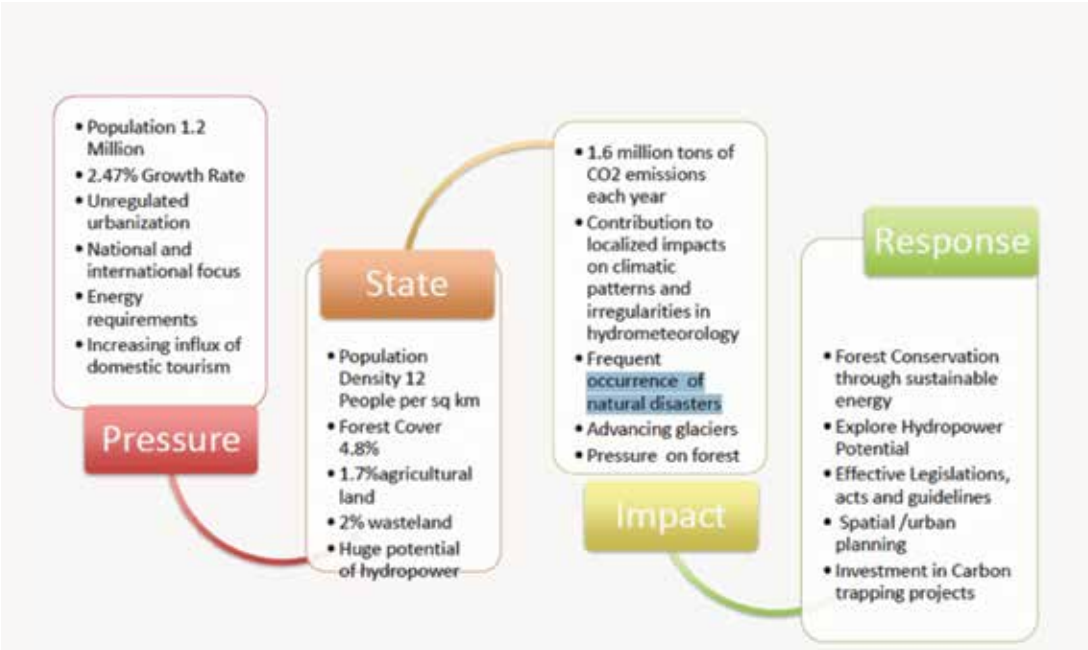

Fig. 5. Main topics to be taken into account when taking management decisions for environmental conservation, especially to challenge climate change impact.

8 - Administrative and policy measures

*(***K. H. Saleem,** *Secretary of Forests, Government Gilgit - Baltistan - Pakistan)*

The main role of local administrations is to help community members and local officials to take a leadership role in ensuring that future development reflects environmental protection as well as fiscal, social and economic community goals. When planning such help, some elements have to be taken into account, for example, "pressure" (i.e. population dynamics, energy requirements,…), "state" (i.e. forest cover, agricultural lands,…), "impacts" (i.e. changes in environment) and "response" (i.e. planning and projects), as summarized in Figure 5.

The entire Gilgit Baltistan area, where the CKNP lies, is particularly susceptible to landslides, formation of lakes and glacier lake outburst floods (GLOFs), forest cover retreat and increased urbanization (then also CO_2 emissions). An impact analysis is therefore needed to advance the approach to climate change adaptation, prepare for long term changes and identify the most vulnerable assets. To address sustainable climate change adaptation, target resources have to be identified as well as spatial planning and management.

The main drivers of climate change are: (*I*) transportation – cars release pollution as they burn gasoline, resulting in the depletion of the ozone layer – (*II*) deforestation – cutting down trees destroys the cycle of photosynthesis, a process that involves converting carbon dioxide (CO_2) into oxygen. With less forestation there will be more CO_2 in the atmosphere – (*III*) landfills – these release methane, one of the most prevalent greenhouse gases, as well as causing pollution – (*IV*) using electronics – electronics, like cell phones, laptops and TVs, release a lot of heat, thus adding to the heat trapped in the earth's surface – (*V*) disturbance in permafrost.

To help the environment's adaptive capacity to climate change, conservation of existing biodiversity has to be enhanced, reducing sources of climate change-related damage, developing ecologically resilient landscapes, establishing ecological networks through habitat protection, restoration and creation, and integrating adaptation and mitigation measures into conservation management, planning and practice. Climate change mitigation refers to the efforts to reduce or prevent the emission of greenhouse gases, using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behavior (e.g. protecting natural carbon sinks, like forests and oceans, or creating new sinks through silviculture, or green agriculture). As for mitigation strategies, in the United Nations Framework Convention on Climate Change (UNFCCC) three conditions are made explicit when working towards the goal of greenhouse gas stabilization in the atmosphere:

a. it should take place within a time-frame sufficient to allow ecosystems to adapt naturally to climate change;

b. that food production is guaranteed (thus, not threatened);

c. that economic development should proceed in a sustainable manner.

Thus, the main mitigation measures are the following: (*I*) promoting cost-effective fuel switching from high carbon fuels to low carbon fuels; (*II*) implementing energy efficiency measures by providing energy-efficiency improvement projects; (*III*) improving existing policies and practices to limit emissions, like controlling subsidies on fuels; (*IV*) measures to raise and expand carbon sinks that trap carbon dioxide, such as forest management and proper land management, etc.; (*V*) improving technology and developing techniques to control methane, nitrous oxide and other greenhouse gas emissions from the source; (*VI*) pre-planning for the adaptation to climate change consequences in the worst case scenario; (*VII*) promoting the use of non-fossil energy sources and conducting research to reduce emissions from existing fossil

fuels; (*VIII*) revising and implementing the energy efficiency standards to check emissions; (*IX*) improving international collaborations among various climate groups and organizations, to better understand the causes and impacts of climate change; (*X*) sustaining research to reduce critical scientific uncertainties and improve existing climate models for better predictions of climate change; (*XI)* promoting environmental education and awareness training on climate change and associated environmental issues in schools and colleges; (*XII*) conducting volunteer programmes and forming regional action groups to implement climate change mitigation measures.

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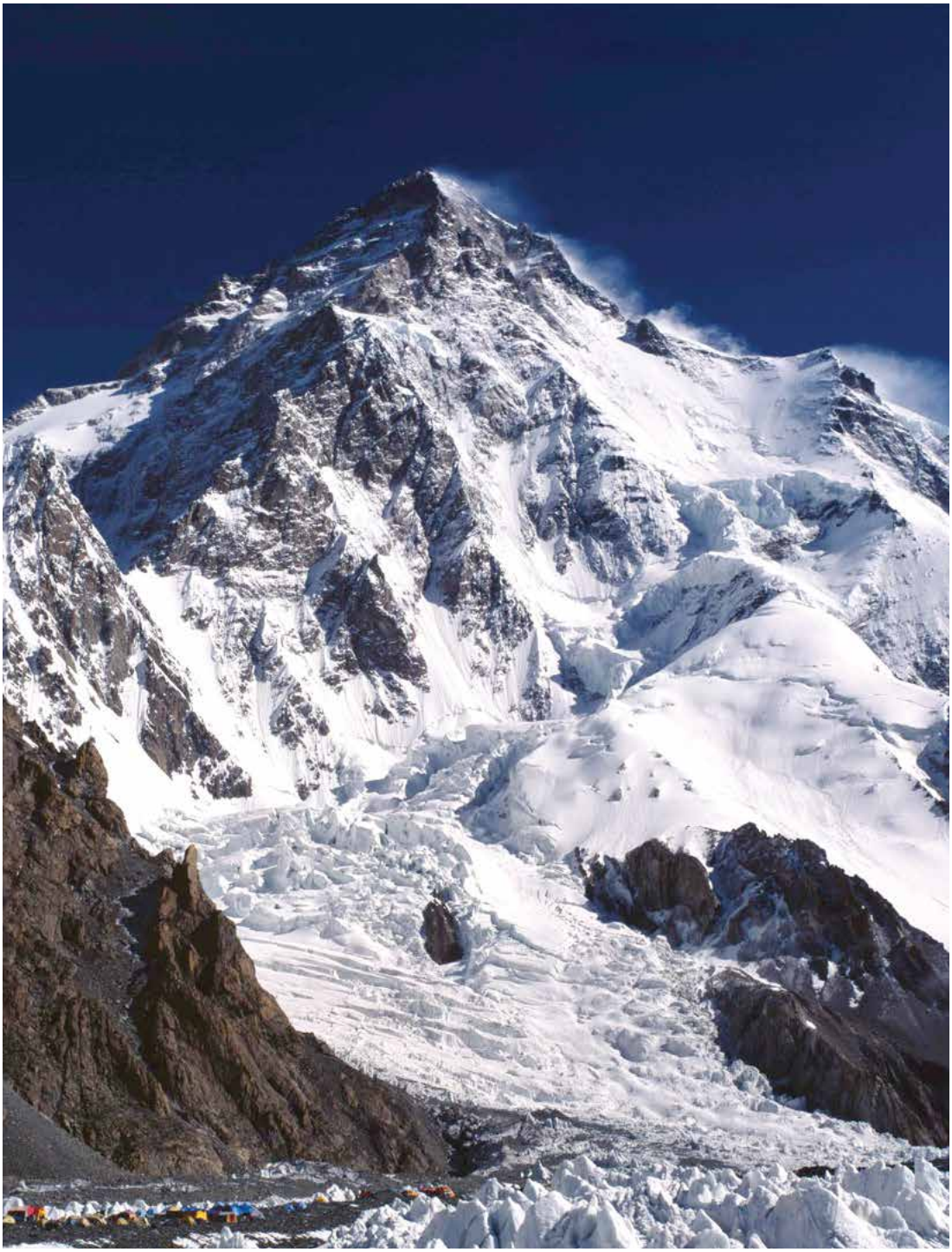


The Central Karakorum National Park

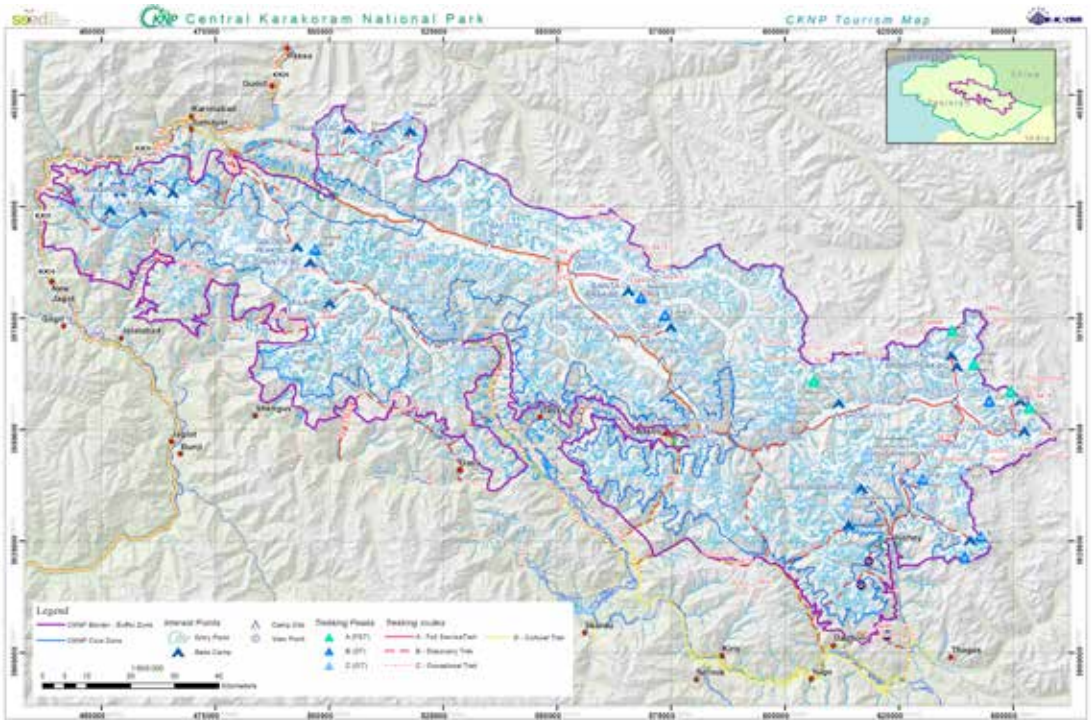
The Central Karakorum in the Northern Area of Pakistan is a mountain area endowed with rich biodiversity, superb natural beauty and important resources. It was declared the Central Karakorum National Park (CKNP) in 1993. Today it is Pakistan's largest protected area , covering 10,557.73 Km^2 in the Central Karakorum mountain range, which includes K2, the second highest peak in the world. It occupies four administrative districts of the Gilgit-Baltistan Region.

The highest Park in all the world

The CKNP encompasses the densest collection of the highest and most precipitous mountain peaks in the world. It includes four, out of the total fourteen, over-8,000-meter-high peaks on Earth – K2, 8611 m, Gasherbrum II, 8035 m, Gasherbrum I, 8080 m, Broad Peak, 8051 m – more than sixty peaks higher than 7,000 metres and more than 700 peaks above 6000 meters.The CKNP area is also the most heavily glaciated part of the world outside the polar regions. The Biafo Glacier, a 67 km-long glacier, meets the 49 km-long Hispar Glacier to create the world's longest glacial system outside the polar regions.
The Baltoro Glacier, 63 km in length, is also one of the longest glaciers in the world.

Fauna: the snow leopard and other mammals

The CKNP is a refuge area not only for threatened species, i.e. markhor, musk deer, urial and snow leopard, but also for not threatened but



important "flag" species, i.e. blue sheep, ibex, lynx and wolf.
The CKNP was proposed in the early 90s of the 20th century to protect the major mountain massifs, watersheds and glaciers of the Central Karakorum region and to constitute a contiguous conservation area with the Khunjerab National Park and the Deosai National Park.

Flora: a precious resource

The vegetation of Central Karakorum National Park covers 14.7% of the park area.
High altitudes, low temperatures, and rough topography restrict the area suitable for plant growth.
In particular, temperature is a limiting factor at higher elevations (above 4500 m), while insufficient water availability during the growing season is impeding plant growth at lower altitudes (below 2000 m, where natural vegetation is mainly found around water bodies, like streams or lakes).
Different vegetation types grow in the CKNP and they are of major importance both for ecological reasons (e.g. as habitat for wildlife, biodiversity conservation) and the sustainment of local communities (e.g. for the provision of grazing ground, firewood, timber). Additionally, environmental services, like protection from soil erosion, regulation of water quantity and quality, nutrient recycling are provided.

The SEED project and the CKNP

The Central Karakorum National Park was declared a National Park in 1993, but only in 2014, thanks to the SEED Project, was the final version of the Management Plan implemented and officially approved by the Gilgit Baltistan Government. In 2014 the Park became fully operational.
The SEED (Socio Economic and Environmental Development) Project, carried out by EvK2CNR, in collaboration with KIU (Karakoram International University), fully financed by the Governments of Italy and Pakistan through PIDSA (Pakistan Italian Debt for Development Swap Agreement), aims at an integrative development of the CKNP region.
Among their many activities, this has involved the establishment of the CKNP and its Directorate, the support to KIU, as well as the promotion of sustainable income-generating activities, thus improving well-being and livelihood options of local people residing in proximity to the National Park.

Park zones, valleys and population

In order to facilitate the maintenance of the Central Karakorum National Park's ecological integrity, whileproviding sustainable management opportunities for local communities and visitors, a zoning system has been implemented. This consists of two main zones, the Buffer Zone and the Core Zone, covering a total of 10,557.73 Km^2 :

CORE ZONE (7,606.83 Km^2): It aims to preserve a unique ecosystem, representative of the CKNP Area. A higher degree of conservation must be ensured.

BUFFER ZONE (2,950.9 Km^2): It is an intermediate zone within the Park's boundaries, where the existing community use rights are permitted and developed in a sustainable way, to assure nature conservation and the possibility of its long-term use by the local communities.

15 Valleys (*Hushey, Thalley, Dhagoni, Shigar, Upper Braldu (Shigar), Lower Braldu (Shigar), Basha (Shigar), Baghicha/Tormik, Astak/Shengus, Haramosh, Bagrote, Ghulmatm, Miachar, Nagar Hunza, Danyore/Jutal/Juglot*) - for a total of 150 villages and 19.688 households (population 151.047) – have the use rights of the Park Surface.

The use rights percentages are defined considering the percentage of the area of jurisdiction of the aggregate valleys on the total of valleys' use rights, over the total Buffer Zone surface.

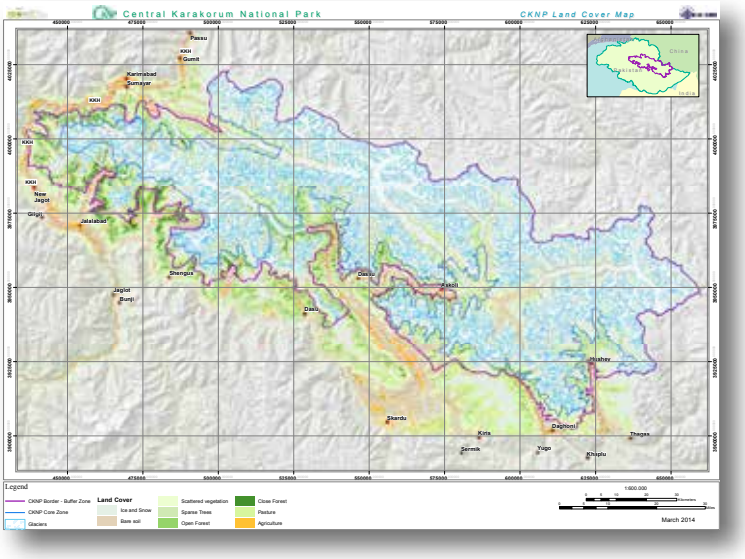
Park management structure

The Central Karakorum National Park (CKNP) is currently managed by a Project Director with a team of 50 members, including the Project Director, Ecologist, Social Organizer, Admin & Finance officer, Range Forest Officers, Game Inspectors, Game Watchers and support staff. The Park Directorate is located at Skardu.

A further the two sub-field offices/ visitor registration centres have been set up at Askoli and Hushey, with CKNP buildings, while the one rented building is situated in Hisper where the visitor registration process is in progress.

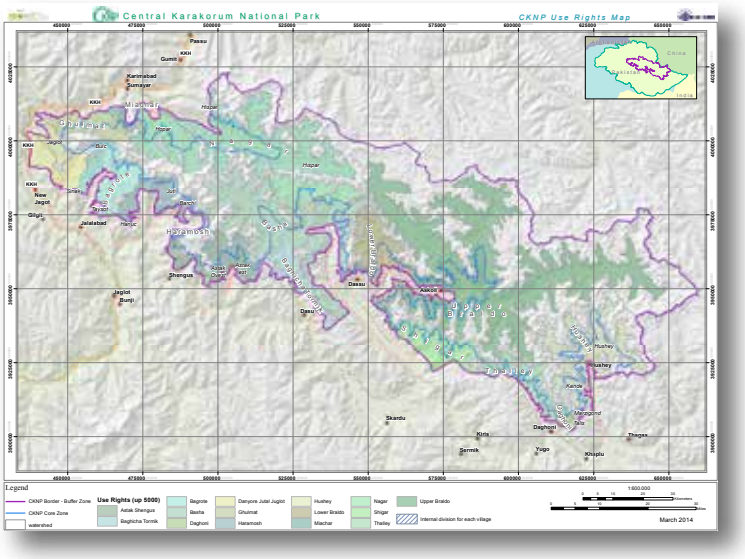
Land cover Map

Reliable thematic maps have been produced, representing fundamental tools to delineate the Park and the related zoning system. Among these, the land cover map, derived from satellite images and ground-based data, has been developed and used in the planning process. The map was used to delineate the following areas: Ice and Snow, Bare Soil, Scattered Vegetation, Sparse Trees, Open Forest, Close Forest, Pasture and Agriculture.



Use rights Map

The fundamental difference regarding land and resource property, ownership and use rights is between the land-categories of the settled area, which is divided into parcels of land under private ownership, and the unsettled area, which is state property and grants local residents use rights on the resources. The former include irrigated areas and parts of the barren land in the immediate surroundings of settlements. The largest part of the municipalities' territory, encompassing artemisia-steppe, sub-alpine and alpine zones, roads, trails, irrigation channels, is categorized as unsettled. While settled areas with ownership rights are recorded in land-registry maps, the distinction of municipal use-right areas in unsettled areas is only documented through narratives and indication of distances from settled areas.



Conference Programme

Scientific Conference: **Karakorum resources and climate change: glacier, water and ecosystem**

September 10, 2013 – 9.00 am
National Art Gallery, Islamabad

9.00 am - Opening Remarks
Najma Najam - *Vice Chancellor of KIU*
Agostino Da Polenza
EvK2CNR Association President
Mr Himayatullah Khan - *Special Secretary to the President of Pakistan*
Mr. Khadim Hussain Saleem
Secretary Forests GB Government
Berend De Groot - *Head of Cooperation, EU Delegation to Pakistan*
Adriano Chiodi Cianfarani
Italian Ambassador

9.30 am - Potential Sites for the Creation of Biosphere Reserves in Pakistan
Chair: **A. A. Khan**
9.30 am - **A. A. Khan** - *Pakistan Scientific Board, EvK2CNR Association - Pakistan*
9.45 am - **M. Rafique** - *Natural History Museum and Focal Point for UNESCO's M&B Programme in Pakistan - Pakistan*
10.00 am - **W. Noor** - *Forest Department Gilgit-Baltistan - Pakistan*
10.15 am - **G. Muhammad** - *Forest Department, Government of Balochistan - Pakistan*
10.30 am - **M. Farooque** - *KP Wildlife Department, Peshawar – Pakistan*

10.50 am - Coffee break

11.05 am - Climate Change in the Karakorum
Chair: **P. Cristofanelli**
11.05 am - **P. Cristofanelli** - *Institute of Atmospheric Sciences and Climate (ISAC), National Research Council (CNR) - Italy*
11.20 am - **G. Rasul** - *Pakistan Meteorological Department (PMD) - Pakistan*
11.35 am - **M. Hussain** - *Karakoram International University, Gilgit-Baltistan - Pakistan*
11.50 am - **A. Tahir** - *Commission on Science and Technology for Sustainable Development in the South (COMSATS) - Pakistan*
12.05 pm - **M. Zia ur Rahman Hashmi** *of Global Change Impact Studies Centre (GCISC) Pakistan*

12.25 pm - Glaciers, Snow and the Hydrological Cycle in Northern Pakistan
Chair: **M. Winiger**
12.25 pm - **D. Bocchiola** - *Hydraulic Division, Politecnico di Milano, EvK2CNR Association - Italy*
12.40 pm - **M. Winiger** - *University of Bonn, I CIMOD - Germany*
12.55 pm - **C. Mayer** - *Bavarian Academy of Sciences and Humanities - Germany*
1.10 pm - **D. Hashmi** - *Glacier Monitoring Research Centre (WAPDA) - Pakistan*

1.30 pm - Lunch

2.40 pm - Extreme Precipitation, Floods in Pakistan – Risk Assessment
Chair: **S. Ullah**
2.40 pm - **F. Gaetani** - Group on Earth Observations (GEO) Secretariat - Switzerland
2.55 pm - **C. Calligaris** - Department of Mathematics and Geosciences, University of Trieste - Italy
3.10 pm - **S. Ullah** - *Environment and Climate Change Unit, UNDP - Pakistan*

3.25 pm - Coffee break

3,45 pm - Environment Impacts, Resources Management and Mitigation Actions
Co-chairs: **F. Mari and Q. Chaudry**
4.00 pm - **Q. Chaudry** - *Climate Affairs, Government of Pakistan - Pakistan*
3.45 pm - **A. Bocci** - *Department of Environmental Sciences G. Sarfatti, University of Siena Italy and* **Muhammad Zafar**, *Karakoram International University and WWF - Pakistan*
4.15 pm - **L. Rossi,** *Department of Veterinary, University of Turin - Italy and* **A. N. Naqvi**, *Karakoram International University, Gilgit-Baltistan - Pakistan*
4.30 pm - **J. Baig**, *Karakoram International University, Gilgit-Baltistan - Pakistan*
4.45 pm - **F. Mari** - *SEED Project, EvK2CNR Association - Italy*
5.00 pm - **K. H. Saleem** - *Forest Department, Gilgit-Baltistan - Pakistan*

5.20 - Conclusion and Poster Session

Conference Organizer

With the patronage of

The Embassy of Italy in Islamabad promotes the political, economic, cultural and scientific cooperation between Italy and Pakistan also trough specific actions and bilateral programmes.

SEED Project is currently carried out in the Gilgit and Baltistan by EvK2CNR Association, in collaboration with the Karakoram International University. The project, fully financed by PIDSA (Pakistan Italian Debt for Development SWAP Agreement), aims at an integrative development of CKNP region through supporting the implementation and management of the park.

EvK2CNR is an autonomous, non-profit association, which promotes scientific and technological research in mountain areas.
Particular emphasis is placed on the Hindu Kush - Karakorum - Himalaya region and on work in the countries of Nepal and Pakistan. EvK2CNR is best represented by its Pyramid Laboratory located at 5,050 meters a.s.l. in Nepal at the base of Mount Everest. Today EvK2CNR's work is mainly organized via broad-scale integrated multi-disciplinary programs aimed at helping resolve urgent environmental and development issues.

Established in 2002 by a charter from the federal government, the Karakoram International University (KIU) has a main campus located in Gilgit that hosts 2300 students, nearly 100 faculty members and over a hundred administrative staff in sixteen academic departments and four disciplines: English, Computer Sciences, Business Management and Education.

in the framework of : *The Italian science and cooperation at the shadow of K2*

Collaborations and partnerships

Published by: EvK2CNR