is not managed through annual harvesting practices, it would be less effective in C sequestration. Therefore, it is essential that culms are harvested annually before they decay and release CO_2 into atmosphere and new culms will emerge with subsequent additional carbon. The harvested bamboo could be used to manufacture durable goods, like building materials for houses, furniture, etc. and can be part of carbon capture and storage.

In NE India, 41.11% of land area is under open or degraded forests. These areas could be utilized for plantation of bamboos which will not only play a vital role in capturing and storing CO_2 efficiently thereby mitigating climate change, but will also boost the economy of people living in and around bamboo forests.

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Seabuckthorn – the natural soil fertility enhancer

Soil contains a number of micro- and macro-elements essential for a plant's growth and development. These mineral nutrients are added to the soil by different natural phenomena. These come either from biodegradable materials or from death and decaying parts of living organisms. They directly or indirectly add a number of organic and inorganic nutrients into the soil which ultimately enrich its fertility. Nitrogen, one of the most essential elements in a plant's nutrition, though abundant in atmosphere, cannot be utilized by the plants directly. While a majority of the plants obtain it from soil, some develop symbiotic association with microbes. Leguminous plants are a well-known example. However, some non-leguminous plants also enter into the symbiotic relationship and contribute significant quantity of fixed nitrogen to their environment.

Hippophae L. is one such non-leguminous nitrogen-fixing plant[1]. It is also the only dominant woody plant inhabiting Ladakh. Covering about 11,500 ha under pure and 30,000 ha under mixed forest plantations[2], the plants of *Hippophae rhamnoides* ssp. *turkestanica* (Figure 1 *a*) have a well-developed tap root system (Figure 1 *b*, *c*). The primary, secondary and tertiary roots are covered with root hairs and form a complex network. This extensive root system reportedly prevents wastage of 90% run-off water and contributes a check on soil erosion to the tune of 95% (ref. 3). The roots enter into a symbiotic association with mycorrhizal fungus *Frankia* (Actinomycetes), leading to the formation of root nodules (Figure 1 *d*–*f*) which fix a substantial amount of atmospheric nitrogen. This interaction also increases the soil root interface and thereby enhances the nutrition uptake[1]. According to Lu[4], the *Frankia* nodulated roots of seabuckthorn fix nitrogen

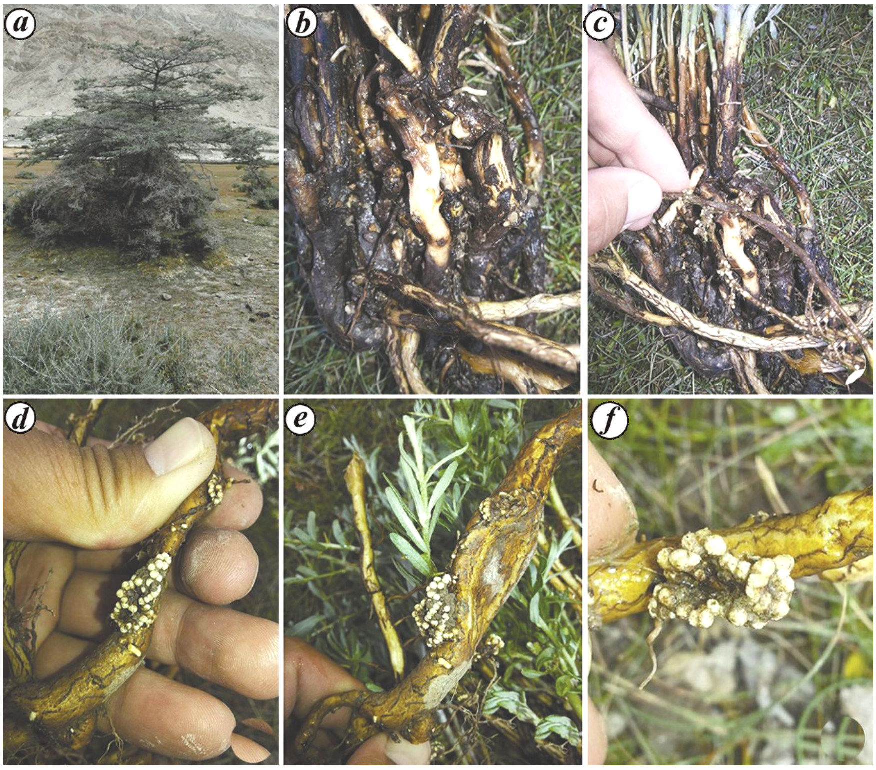

Figure 1. ***a***, An individual plant of *Hippophae rhamnoides* L.; ***a*–*f***, Root of the mature plant. Mature root without nodule (***b***) and with nodule (***c*–*f***).

twice more than that of soybean and @ 80 kg/hectare/year (refs 2, 5). According to some, the quantity can be as high as 170–180 kg/hectare/year. Therefore, seabuckthorn can play a crucial role in increasing the fertility of soil in areas like Ladakh (J&K) and Spiti (HP).

Ladakh, considered the cold desert of India, is characterized by dry climate and temperature fluctuations from below –30°C in winter to above +35°C in summer. The soils of this region are poor in mineral nutrients[6] and the vegetation is scanty and deciduous. The species was exploited for the first time by DIHAR (former FRL), Leh under the Cold Desert Afforestation programme[7]. Therefore, seabuckthorn can convert the barren land of Ladakh into a fertile and tillable one.

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Increasing hydrological hazards in the Himalayas: defence lies in integrated scientific preparedness

The increasing rate of water-related hazards in India is a matter of concern for the society and a challenge for the Government. In the last five years, NW Himalaya alone has witnessed three major events of rain-induced floods and each one made a new record in terms of loss of human lives and damage to infrastructure and landscape. The main reasons for these unprecedented losses have been our unpreparedness, unmindful occupation of hazardous areas, deforestation, poor knowledge of the geo-environment and insufficient forecasting capabilities. As a result, these events adversely impact the dynamic geo-environment of the terrain, social psyche and financially overburden both public and Government in rescue, relief, restoration and rehabilitation. No amount of preparedness without scientific urban planning, understanding of the Earth surface processes in terms of mass movements of debris, soil and water and other factors such as deforestation can arm a society to face these kinds of natural disasters.

The last two events have occurred suddenly in high-altitude areas of Leh and Kedarnath due to short spells of incessant rains or cloud burst due to accelerated monsoon and westerly disturbances or their confluence[1]. Because of high drainage density and gradient, such terrains have a small lag time[2] of flood generation facilitated by the rapid transfer of water from low order *nullas* to higher order streams. This successive discharging of streamlets in the main channel not only enhances the volume of water, but also its strength to erode and transport, that leads to floods and flows in downstream areas. The August 2010 floods of Leh triggered by 75 mm rainfall in 30 min killed more than 600 people while affecting ~60 villages[3]. The mud debris transported by *nullas* was deposited in the lower part of valleys burying houses and people. A similar event on 16 and 17 June 2013 in the upper reaches of the Mandakini and Alaknanda valleys in Uttarakhand Himalayas killed around 4000 people[4], destroyed roads and houses, induced landslides, eroded the human-occupied river terraces, and transported and deposited sediments at critical sites[1,2,5]. The magnitude and spread of the 6 and 7 September 2014 floods in parts of Jammu and Kashmir is also of extraordinary nature.

Flooding is caused by excessive water, originated due to natural or anthropogenic reasons. Many a times it may not be stoppable unless we have prior knowledge and are fully prepared. However, for geoscientists aiming to provide vital inputs to the society at large, two relevant questions of extreme importance can be framed: (i) Can flooding happen anywhere, or can controls be defined? (ii) Is there any scope of safeguarding ourselves and our properties from floods?

Nature has a systematic way of transferring its water from source to sink. Any obstruction in the natural path alters its flow behaviour. Each river basin has a hierarchy of landforms to accommodate and regulate its normal and excessive water volume. During lean season water flows in the active channel without causing floods, unless it has been encroached. When discharge increases due to excessive rain, water spreads on the next higher active floodplain. A further increase will raise the water to a still higher level of older floodplains, known as terraces limited by palaeo-banks. In the rarest case, a river may overspill its palaeo-bank. Flooding occurs when water inundates terraces which are preferred urbanization surfaces due to even topography and water proximity. The human occupation of natural flooding surfaces of a river and interventions in its course further augments the destructive capacity of floods.

The devastation caused due to floods in Leh, Uttarakhand as well as Jammu and Kashmir are typical cases of unscientific land use ignoring the geomorphology of drainage basins. In Ladakh, it was houses on dry *nullas* (Choglamsar, Leh, etc.), while in Uttarakhand it was the occupation of river course in Kedarnath valley, habitation on the unstable terraces and vulnerable hill slopes on river valley sides. These deposits and slopes were eroded during the overbank flow of river causing loss of life, property and infrastructure.

In some situations, at the time of excessive river discharge, flooding cannot be prevented, though its magnitude, intensity and impact can be considerably regulated and reduced through scientific planning in development. However, the main problem we face today is that large