Mitigation of groundwater depletion hazards in India

This letter addresses issues concerning future sustainability of the groundwater resources in response to the effects of climate and demand-related pressures. Recent data on the status of groundwater resources in India reveal several alarming trends. Groundwater is a critical resource in India, accounting for over 65% of irrigation water and 85% of drinking water supplies. Groundwater is the world's largest freshwater resource; it is critically important for irrigated agriculture and hence for global food security. Water security is widely recognized as one of the major challenges to India's economic and social development. Per capita availability of water in India has declined from over 3000 m^3/year in 1951 to 1800 m^3/year in 2010. The combination of these climatic conditions with a range of man-made pressures has driven India's farmers, households and industry to increasingly depend on groundwater rather than surface water in rivers and lakes.

The groundwater is considered to be less vulnerable than surface sources to climate fluctuations and can therefore help stabilize agricultural populations and reduce the need for farmers to migrate when drought threatens agricultural livelihoods. In other words, groundwater resources provide a reliable drought buffer in large regions of the world[1]. Groundwater irrigation has been expanding at a rapid pace in India since the 1970s. The share of groundwater in the net irrigated area has also been on the rise[2]. For the net irrigated area of about 29.75 m ha between 1970 and 2007, groundwater accounted for 24.02 m ha (80%). On an average, between 2000–01 and 2006–07, about 61% of irrigation in the country was sourced from groundwater[2]. The share of surface water has declined from 60% in the 1950s to 30% in the first decade of the 21st century[3].

The status of groundwater resources in the country is a matter of serious concern. It is estimated that 60% of groundwater sources will be in a critical state of degradation within the next 20 years. A recent assessment by NASA showed that during 2002–2008, three states (Punjab, Haryana and Rajasthan) together lost about 109 km^3 of water leading to a decline in the water table to the extent of 0.33 m/annum[4]. In order to feed a growing and wealthier population, it is projected that agricultural water demand in India of 2030 would need double to 1200 billion m^3 (ref. 5) if these inefficient practices continued. Currently, these water bodies are not in good condition and prolongation of the current situation will surely lead to a worse situation.

The physical absence of the resource, the state of groundwater quality in India is a critical health issue. As wells are drilled deeper in pursuit of the falling water table, the water which is extracted frequently displays higher levels of arsenic, fluoride and other harmful chemicals. Falling water tables can also induce leakage from a contaminated external source, such as saline water in coastal areas or surface water polluted by sewage, agricultural fertilizers and industry. This problem needs urgent attention because groundwater is the source of drinking water for over 80% of rural households.

There is scope for further groundwater development for irrigation and domestic purposes. Groundwater development should be coupled with management of rainwater and surface water. The existing water resources and dug wells, ponds and streams should be protected and conserved. Rainwater harvesting and artificial recharge schemes should be taken up on a massive scale. An essential part of management of the resource is proper spacing of abstraction structures. The impact of artificial recharge to groundwater shall be created mainly at the downstream side of the recharge structures. There is also need for creation of awareness among the public on judicious use of groundwater resources and for capacity-building of stakeholders at the grassroot level on various aspects of groundwater conservation and augmentation.

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Shrinkage of Chinese Internet resources

The Internet continues to grow day by day making McLuhan's 'Global Village' a reality[1]. Chinese Internet resources have increased and developed quickly since 1995, when two Internet access points were installed in Beijing and Shanghai. The latest statistics from China Internet Network Information Center (CNNIC, http://www.cnnic.cn) shows that the population of Chinese Internet users has reached 0.564 billion out of the 1.337 billion residents by December 2012.

As the official Internet statistics in China, CNNIC releases Chinese Internet data twice a year since 1997, including the number of IP addresses, domains, websites and the number of Internet users. The number of Chinese Internet

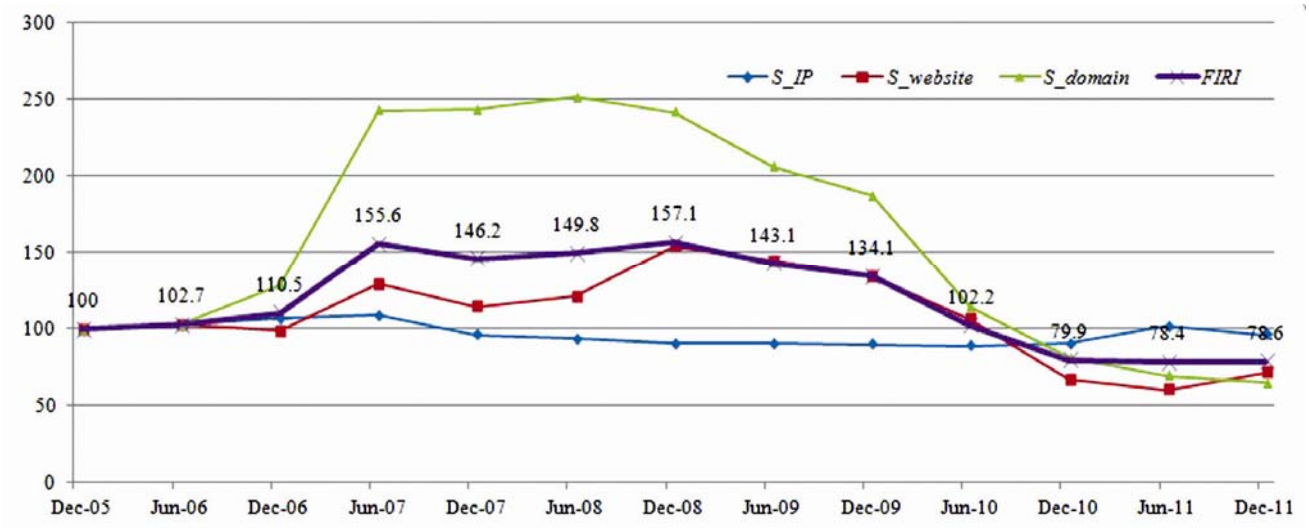

Figure 1. The trend of Chinese Internet resources.

Table 1. Change in the number of domains, '.cn domains', websites and '.cn websites' in China from 2006 to 2011

	Domain		.cn domain		Website		.cn website	
Year/month	*N*	Change	*N*	Change	*N*	Change	*N*	Change
2006/12	4,109,020		1,803,393		843,000		367,418	
2007/12	11,931,277	7,822,257	9,001,993	7,198,600	1,503,800	660,800	1,006,000	638,582
2008/12	16,826,198	4,894,921	13,572,326	4,570,333	2,878,000	1,374,200	2,216,400	1,210,400
2009/12	16,818,401	–7,797	13,459,133	–113,193	3,231,838	353,838	2,501,308	284,908
2010/12	8,656,525	–8,161,876	4,349,524	–9,109,609	1,908,122	–1,323,716	1,134,379	–1,366,929
2011/12	7,748,459	–908,066	3,528,511	–821,013	2,295,562	387,440	951,609	–182,770

users has been increasing exponentially since 1997. Nevertheless, the current penetration rate is only 40.1%, above the world average (27.5%), but far behind that of South Korea (82.5%), Japan (79.5%) and Singapore (75.0%) in Asia (http://internetworldstats.com/stats3.htm). With the availability of 3G phones in China, mobile Internet is becoming popular. In 7 January 2009, the Ministry of Industry and Information Technology issued 3G communication network licence. In just four years, the number of users has increased from 0.013 billion to 0.420 billion.

Internet measurement research has grown in scope and magnitude to match the growth of the Internet[2,3]. In this study, Fundamental Internet Resources Index (FIRI) is proposed to measure the richness of internet resources. It comprises the number of IP addresses per 1000 users, websites per 1000 users and domains per 1000 users. Standardized and weighted calculations are applied prior to adding the three sets of data together, e.g. S_{domain} = (current period value × 100/base period value), and similarly for S_{website} and S_{IP}. Then FIRI = $0.368 \times S_{\text{IP}} + 0.334 \times S_{\text{website}} + 0.368 \times S_{\text{domain}}$. The base period value is the one in December 2005. The weights of the three Internet resources are determined by expert judgement.

The value of FIRI increased from 2005 and peaked by the end of 2008. Thereafter, it declined and halved to 78.6 by December 2011 (Figure 1). This trend indicates that the fundamental Internet resources that Chinese users share are shrinking. That is, more and more users are sharing less and less fundamental Internet resources. The value of S_{IP} stablizes around the base period value, which indicates an exponential growth in the number of IP addresses, similar to that of the users. However, the Asia Pacific Network Information Centre, Australia has cl`aimed the exhaustion of IPv4 addresses in the Asia Pacific region in April 2011. Meanwhile, IPv6 has been adopted. The curves of S_{domain} and S_{website} show almost the same trend as that of FIRI (Figure 1). Their fluctuation results in the increasing and thereafter decreasing trend of Chinese Internet resources.

The change of domains and websites is mainly determined by that of '.cn domains' and '.cn websites' respectively. Table 1 shows that, the change of .cn domains is almost equal to that of the domains and the change of .cn websites is almost equal to that of the websites. Correlation analysis shows that their coefficients are as high as 0.995 and 0.929 respectively. The number of domains is correlated with that of websites, with coefficient of 0.629. It demonstrates that the change in the number of domains leads to the change in the number of websites. Therefore, it is concluded that the increasing and thereafter decreasing trend of Chinese Internet resources is caused by the rise and fall in the number of '.cn domains'.

The registration and utilization of .cn domains is under the supervision of CNNIC. According to CNNIC, the

number of .cn domains has increased significantly. On 7 March 2007, CNNIC claimed that the registration cost of a .cn domain is priced at only one yuan, which resulted in cybersquatting afterwards. The number of .cn domains doubled within a month after the claim, and it quintupled in a year (http://www.cnnic.net). However, the cybersquatting brought hidden troubles, such as illegal application of .cn domains for pornographic sites, phishing sites, etc. In December 2009, the CNNIC enforced clearance of illegal .cn websites, in line with the action of the Ministry of Public Security. Meanwhile, CNNIC announced that since 14 December 2009, individuals can no longer register .cn domains and a paper application has to be submitted for registering, along with photocopies of the company business license and registrant ID. Therefore, the number of .cn domains reduced to one-third in a year from 13.459 million to 4.350 million; on an average about 24,956 .cn domains were removed out from the Chinese Internet every day.

The shrinkage of Chinese Internet resources is mainly due to the regulation of CNNIC, rather than the action by the Ministry of Public Security, the General Administration of Press and Publication, etc., which are responsible for the censorship of Internet content. As a non-profit organization affiliated to the Chinese Academy of Sciences, CNNIC is in charge of domain name registry services. It is concluded that the shrinkage of Chinese Internet resources since 2009 is not due to censorship of content or political control[4,5], but because of the regulation of domain name registry services.

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Vulture decline – an ecosystem crisis

The letter by Bohra[1] is interesting and highly informative. Decline of vultures is a serious ecosystem problem with negative consequences. Rotting caracasses constitute the favourite and typical diet of vultures. Thus, through their scavenging habits, vultures provide an important link in checking and containing the spread of infectious diseases among animals and even human beings. The concern raised by Bohra[1] is timely and calls for immediate action. He has reported the death of 80 vultures from the Jorbeer dead animal dumping site due to poisoning effects. Evidently, the situation is alarming. During the past few years, vultures are vanishing not only from India but from other parts of the world sky and going towards extinction. The *IUCN Red Data Book* has listed this bird as 'critically endangered'.

Out of the 1200 bird species found in India, 8 belong to those of the vultures. The most common among them is the 'Indian scavenger', which was practically found throughout the country. However, over the years a number of species like the Indian king, long-billed griffon and Himalayan griffon have become a rare sight these days. Many have simply vanished and may be found in the high mountain ranges. Over the last decade, long-billed vulture has declined by more than 95% and moved onto the *IUCN Red Data Book* list as 'critically endangered'. Similar declines have been reported from Himachal Pradesh, Jammu and Kashmir, Rajasthan, Karnataka and Tamil Nadu, where the population is rapidly disappearing. The present author has seen a number of unbeaten carcasses while on road journey between Jammu and the surrounding areas. The reasons for declining vulture populations include increasing urbanization, rampant use of pesticides in agricultural production, mounting pollution and widescale killing for their meat, increasing air traffic and lack of perching and nesting sites. In the light of the above, it is necessary that further decline be arrested. Although no definite control measures have been known so far, the tribal people can be educated regarding the importance of vultures to stop their killings[2]. Airport authorities can also be approached not to kill vultures relentlessly. Captive breeding as is being followed in Himachal Pradesh needs to be started in other states also. Use of pesticides in agriculture needs to be minimized[3]. Proper consultation with a veterinarian before throwing out carcasses that have been treated with any non-steroidal anti-inflammatory drugs such as diclofenac, should be done as a precautionary measure[3]. Chaudhry *et al.*[4] reported that populations of the critically endangered long-billed vulture (*Gyps indicus*) in Pakistan have increased following the ban of the toxic veterinary drug diclofenac in South Asia. Similar efforts are required to fully implement the ban to eliminate diclofenac from the food supply of vultures[5].

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