Spatial Information Technology Applications in Other SDGs

14

Abstract

Spatial information technology has wide applications for humankind. With the advent of the latest technology, spatial information technology has improved the capacity to resolve complex issues in digital environments and modelling for the future. There are 17 Sustainable Development Goals (SDGs) to be fulfilled by 2030. The present study highlights the role of spatial information technology in SDGs, such as: no poverty, zero hunger, good health and well-being, quality education, gender equality, clean water and sanitation, affordable and clean energy, decent work and economic growth, sustainable cities and communities, life below water, peace, justice and strong institutions and partnerships for the goals. This technology provides comprehensive digital database creation, analysis and mapping facilities of past and present scenarios as well as future modelling.

Keywords

Zero hunger · Inclusive and equitable education · Empowerment of women · Sustainable economic growth · Resilient infrastructure

14.1 Introduction

Spatial information technology has the capacity to create, analyse, model and develop the spatial applications and visualisation of geographical phenomena and features. The development of new databases and updation of existing databases in a timely manner is an important feature of the technology that enables us to create analysis activities such as: relationship between features, clustering, aggregation, statistics generation by using overlay, buffer and networking processes. The output of the geospatial database is depicted through visualisation techniques in the form of maps, charts and statistics in hard and soft copies. With the advantage of programming applications, interactive maps and web apps, new tools are developed for analysis and geo-visualisation. Thus, spatial information technology provides comprehensive mapping facilities of past, present and future scenarios to help achieve SDGs in a timely manner.

14.2 Goal 1: No Poverty: End Poverty in All Its Forms Everywhere by 2030

The SDG 1 target is to eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day. Poverty

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means 'the state of being extremely poor' or in other words, the state of being inferior in quality or insufficient in amount. Basically, it refers to the complete lack of basic needs for livelihood such as food, clothes and shelter. India accounted for the largest number of people living below the international poverty line in 2013 with 30% of its population under the $1.90 per-day poverty measure of the World Bank. Information about poverty and tracking progress toward this goal is very important to alleviate this issue. Here remote sensing and GIS play an important role to provide high-resolution satellite data, which is continuously mapping the Earth and providing socio-economic indicators of poverty and wealth such as poor and rich colonies (Fig. 14.1). The World Bank has also prepared a map showing the country-level poverty estimates used to generate the 2013 regional and global poverty estimates, which draw on data from more than two million randomly sampled households, representing 87% of the total population in 138 low-, middle- and high-income countries (www.worldbank.org) (Fig. 14.2). Target 1.2 is to reduce half of the

Fig. 14.1 Rich and poor neighbourhoods in parts of Delhi, India (*Source* https://www.google.co.in/maps/@28.568947,77.1736174,146m/data=!3m1!1e3?hl=en)

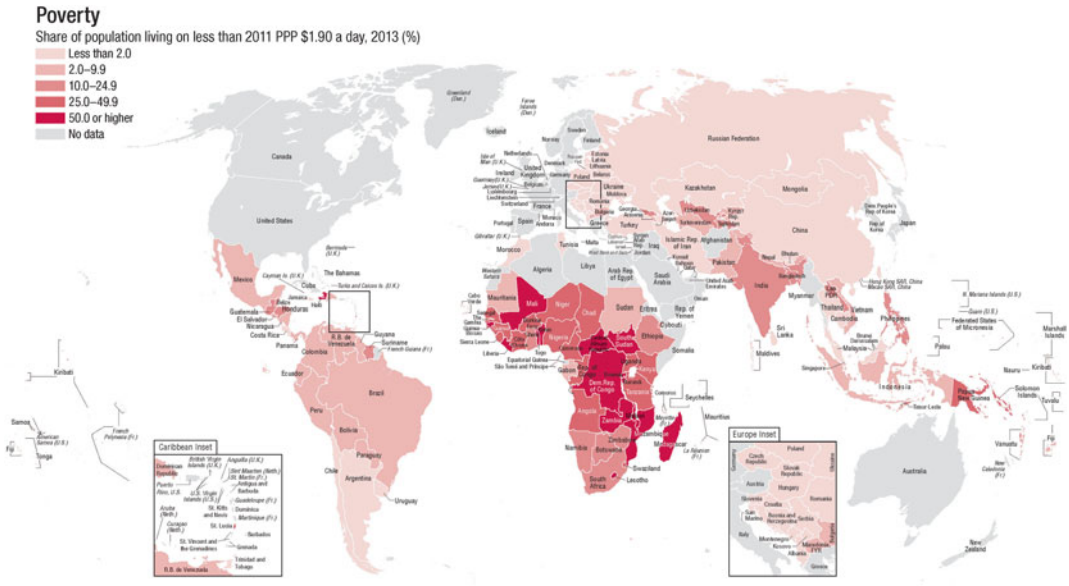

Fig. 14.2 Poverty map of the world (*source* www.worldbank.org)

proportion of men, women and children of all ages living in poverty by 2030. In this regard timely information about the proportion of the population living below the national poverty line by age and sex can be mapped to show regional and local disparity.

14.3 Goal 2: Zero Hunger: End Hunger, Achieve Food Security, Improve Nutrition and Promote Sustainable Agriculture

The target of SDG 2 is to end hunger and ensure access by all people – in particular the poor and people in vulnerable situations, including infants – to safe, nutritious and sufficient food by the year 2030. Spatial information technology is capable of providing information on sustainable agriculture and food security by the continuous monitoring and assessment of environmental conditions. FAO also produces a broad series of geospatial data and information from land-use/cover changes to map poverty for policy formulation at various levels and to meet the SDGs. This means ensuring sustainable food production systems, implementing resilient agricultural practices and increasing productivity and production that helps to maintain ecosystems that strengthen capacity for adaptation to climate change, extreme weather, droughts, flooding and other disasters and that progressively improve land and soil quality. A case study on 'Crop Modelling for Sustaining Agriculture Productivity' is discussed to demonstrate the role of spatial information technology (Fig. 14.3).

14.4 Goal 3: Good Health and Well-Being: Ensure Healthy Lives and Promote Well-Being for All at All Ages

The SDG 3 target is to reduce the global maternal mortality ratio to less than 70 per 100,000 lives. This means putting an end to preventable deaths of newborns and children under 5 years of age with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1000 live births, and under-5 mortality to at least as low as 25 per 1000 live births. Despite the gains achieved during the Millennium Development Goal (MDG) era, every day 16,000 children under the age of 5 still die. During 1990 to 2015, 236 million children died before reaching their fifth birthday (United

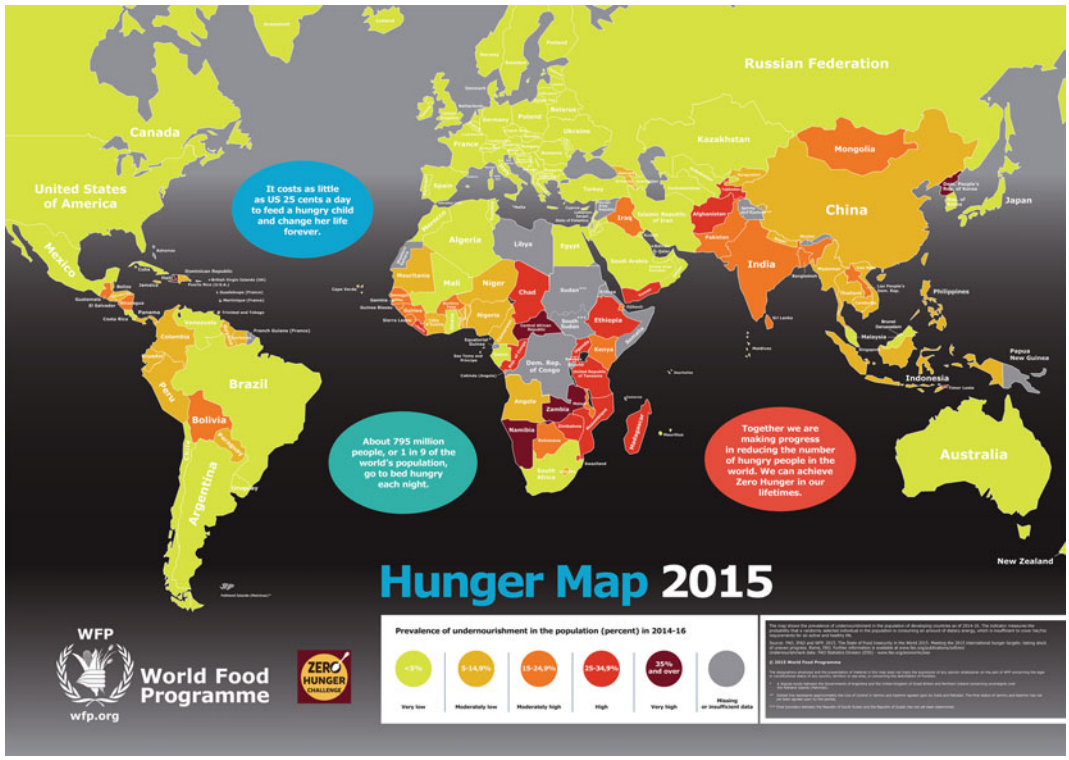

Fig. 14.3 Hunger map of the world 2015 (*source* http://documents.wfp.org/stellent/groups/public/documents/communications/wfp275057.pdf?_ga=2.31474430.1783817753.1514181170–910013392.1514181170)

Nations International Children's Emergency Fund [UNICEF]). According to United Nations Interagency Group for Child Mortality Estimation (UN IGME), Sub-Saharan Africa remains the region with the highest under-5 mortality rate in the world, and when including figures for South Asia this accounts for more than 80% of global under-5 deaths (Fig. 14.4). The spatio-temporal information about infant mortality rates of two time periods in India is shown in Fig. 14.5. United Nations International Children's Emergency Fund has also estimated the achievement of the SDG's target on child mortality by year and country (Fig. 14.6). By 2030, it forecasts the end of the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and the further combatting of hepatitis, waterborne diseases and other communicable diseases. Spatial information technology has been successfully implemented for over 50 years in examining the role of environmental factors in waterborne, airborne, soil-borne and vector-borne diseases. The World Health Organization (WHO) also recognises the capability of geospatial technology and applied it in the elimination of leprosy (http://www.who.int/lep/monitor/gis/en/index2.html). Location is the most important factor in health-related issues. It may be the location of a specific disease or of health facilities available.

14.5 Goal 4: Quality Education: Ensure Inclusive and Equitable Quality Education for All and Promote Lifelong Learning

Spatial information technology plays an important role in analysis, policy formulation and decision-making in the field of education systems. In order to achieve SDG 4, it is necessary to find up-to-date information about literacy rates,

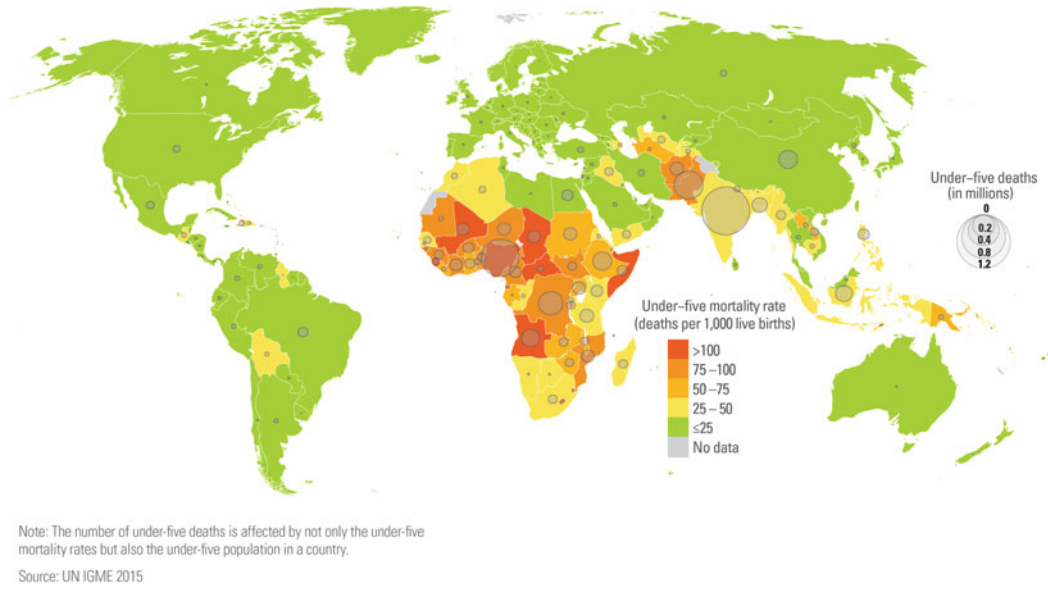

Fig. 14.4 Under-5 mortality rate and under-5 deaths by country, 2015 (*source* UN IGME, 2015)

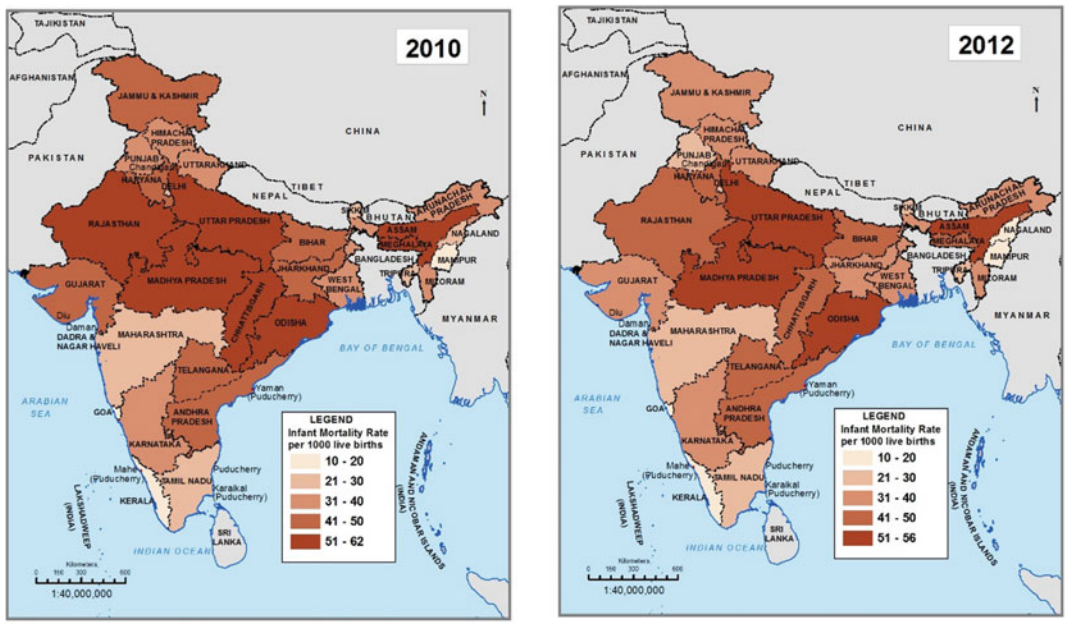

Fig. 14.5 Infant mortality rate in India (*source* Census of India)

education facilities, the number of educational institutes, the number of school-going boys and girls, student–teacher ratios, infrastructure available in schools etc. Information about literacy rates, primary schools, middle schools and adult literacy centres in Bhojpur district in Bihar, India is shown in Fig. 14.7. Such information is very important for making any decision for quality education for all (Fig. 14.7). According to UNICEF, more than half of countries and areas worldwide have achieved or nearly achieved universal primary education (Fig. 14.8).

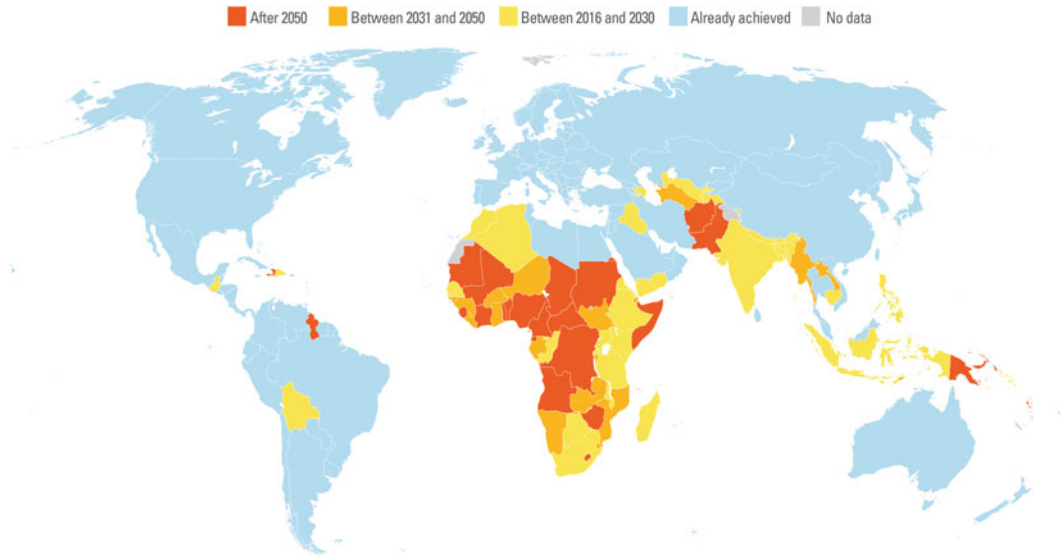

Fig. 14.6 Achievement of SDG targets on child mortality by year and country (*source* UNICEF analysis based on UN IGME, 2015)

The literacy rate among youth and adults is showing increasing trends because of the expansion of educational opportunities. Globally, the youth literacy rate increased from 83% to 91% during 1985 to 2013. The spatial distribution of youth literacy (Fig. 14.9) shows that countries in West and Central Africa have a very low literacy rate.

14.6 Goal 5: Gender Equality: Achieve Gender Equality and Empower All Women and Girls

The dictionary meaning of gender equality is the state in which access to rights or opportunities is unaffected by gender. According to UNICEF, this means that women and men, and boys and girls, enjoy the same rights, resources, opportunities and protection. Gender equality refers to the equal rights, responsibilities and opportunities of women and men and girls and boys. Equality does not mean that women and men will become the same but that women's and men's rights, responsibilities and opportunities will not depend on whether they are born male or female. Gender equality implies that the interests, needs and priorities of both women and men are taken into consideration, recognising the diversity of different groups of women and men. Gender equality is not a women's issue but should concern and fully engage men as well as women. Equality between women and men is seen both as a human rights issue and as a precondition for, and indicator of, sustainable people-centred development (http://www.un.org/womenwatch/osagi/gendermainstreaming.htm). The SDGs offer a historic opportunity to pursue transformational measures to ensure equality for every woman and girl. Investing in women's economic empowerment sets a direct path towards gender equality, poverty eradication and inclusive economic growth. The inclusion of women and girls in the economy and the provision of safe working and public spaces must be accompanied by measures to prevent violence against women and girls, and enable them to participate fully in society and contribute to the health and prosperity of their communities. In India, Haryana State ranked at the bottom in terms of sex ratio at birth, with 857 girls for every 1000 boys in 2012.

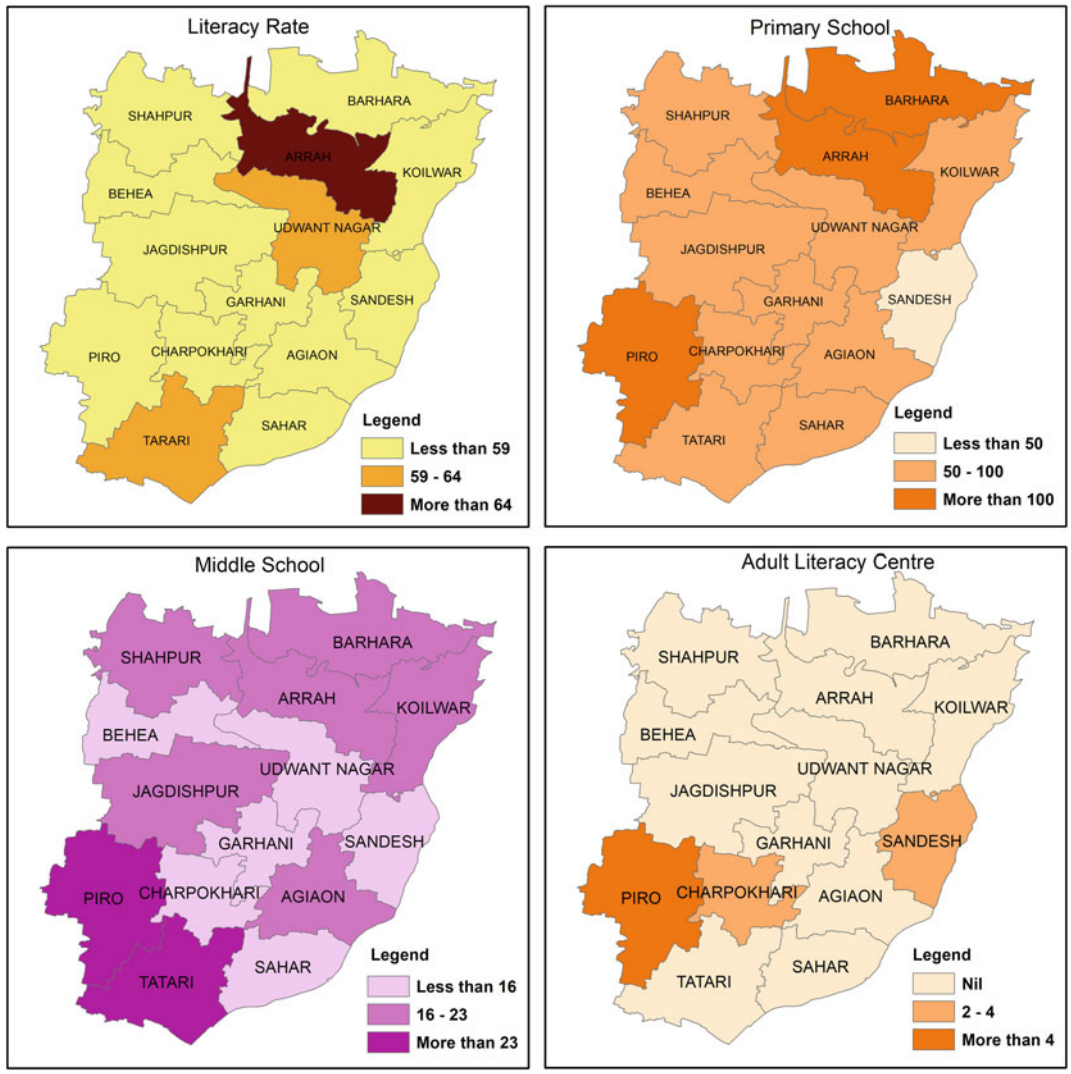

Fig. 14.7 Information about education such as literacy rates, distribution of primary, middle schools and adult literacy centres in Bhojpur district, Bihar, India

This number was 868 in 2013, 871 in 2014 and 876 in 2015. Because of the government's signature *Beti Bachao, Beti Padhao* campaign to save and educate the girl child, Haryana's daughters have a new spirit of life and empowerment (http://paper.hindustantimes.com/epaper/viewer.aspx, dated 21 December 2017) (Fig. 14.10). So the spatial distribution of the sex ratio is very useful for the formulation of plans for the development of women (Fig. 14.11).

The Woman Stats Project is a team of students dedicated to the continual expansion of the WomanStats Database, as well as the pursuit of a research agenda assessing the relationship between the situation and security of women with the aid of maps available on its website (www.womanstats.org). Various issues related to women are mapped, such as child marriage for girls, practice and laws, maternal mortality rate, birth rate, life expectancy of women etc. (Fig. 14.12). Various government initiatives aim

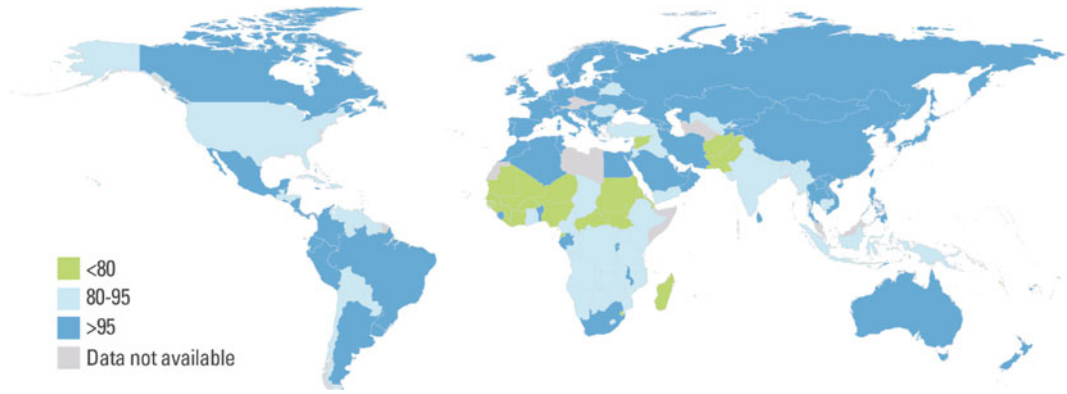

Fig. 14.8 Primary school net enrolment rate or net attendance rate (percentage), 2015

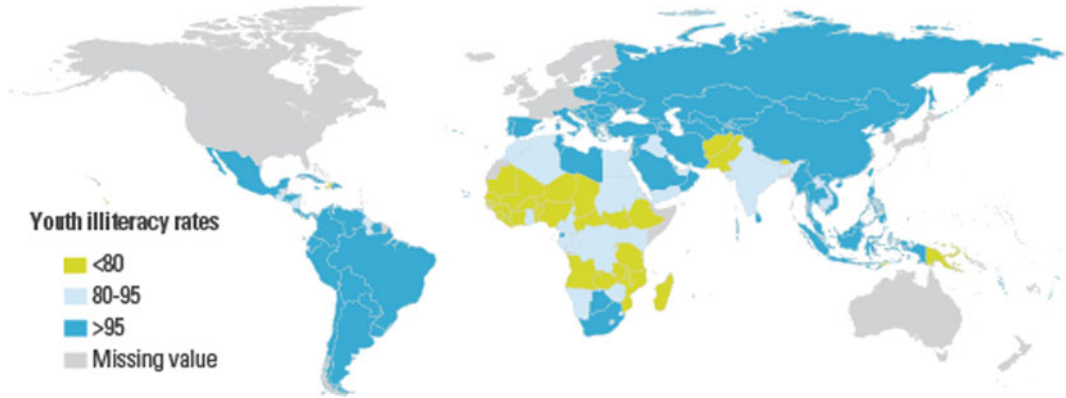

Fig. 14.9 Youth illiteracy rates, 2014

at improving women's physical and societal well-being.

14.7 Goal 6: Clean Water and Sanitation: Ensure Access to Water and Sanitation for All

Geospatial technology is widely applied to provide spatial information on clean water and sanitation. Achieving universal and equitable access to safe and affordable drinking water for all is one of the targets of this goal (Singh and Kumar 2014). Huge disparities lie in access to drinking water (Mathur et al. 2005). Developed countries have achieved the goal but less-developed countries are still miles away, particularly those in Saharan Africa where less than 50% of the population have access to basic drinking water (Fig. 14.13).

The figure shows that between 91% and 100% of the population has access to basic drinking water, except in Africa and South Asia. Besides this global data, there is a large disparity within countries (see Chap. 12, Fig. 12.3). Target 6.2 is to achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations. WHO/UNICEF JMP is monitoring the data on drinking water, sanitation and hygiene (WASH). Simultaneously, they are providing their services through various forms of visualisation techniques (Fig. 14.14).

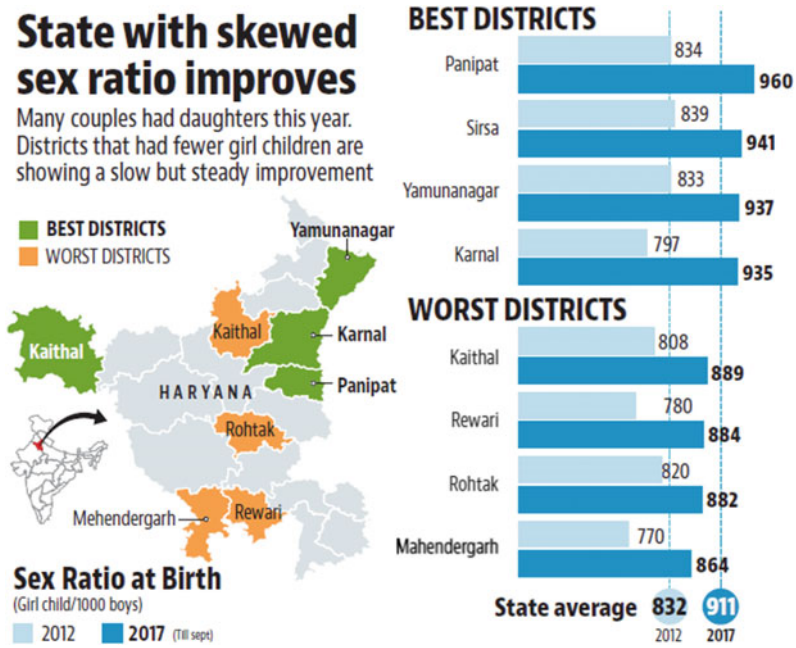

Fig. 14.10 Improved sex ratio in Haryana, India

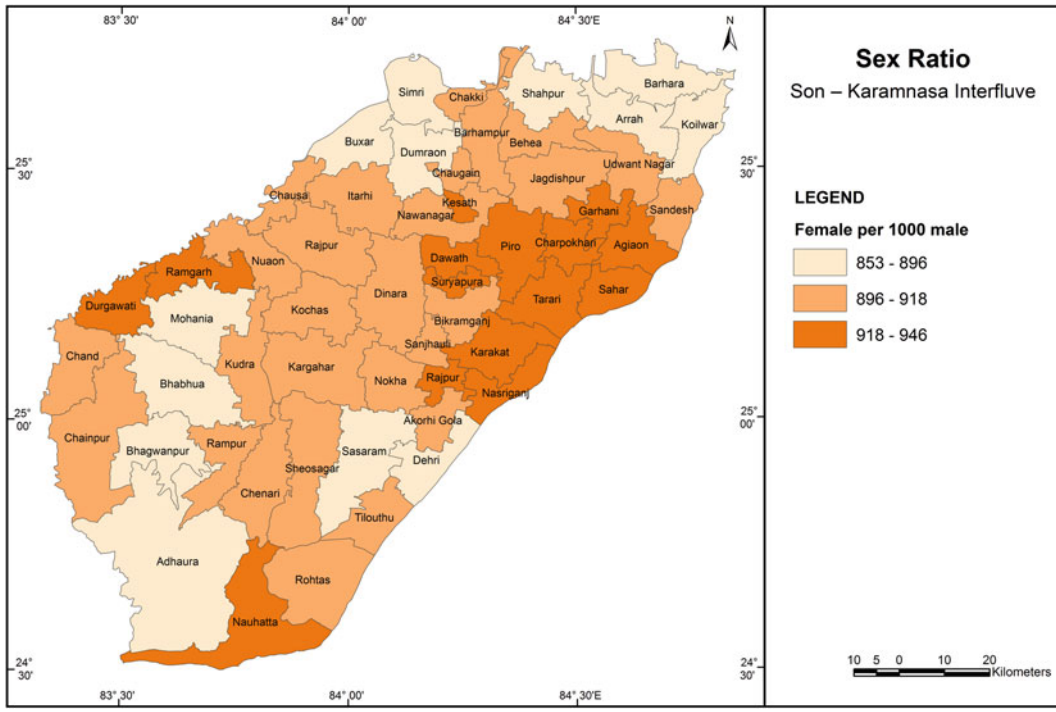

Fig. 14.11 Spatial distribution of sex ratio in parts of Bihar, India

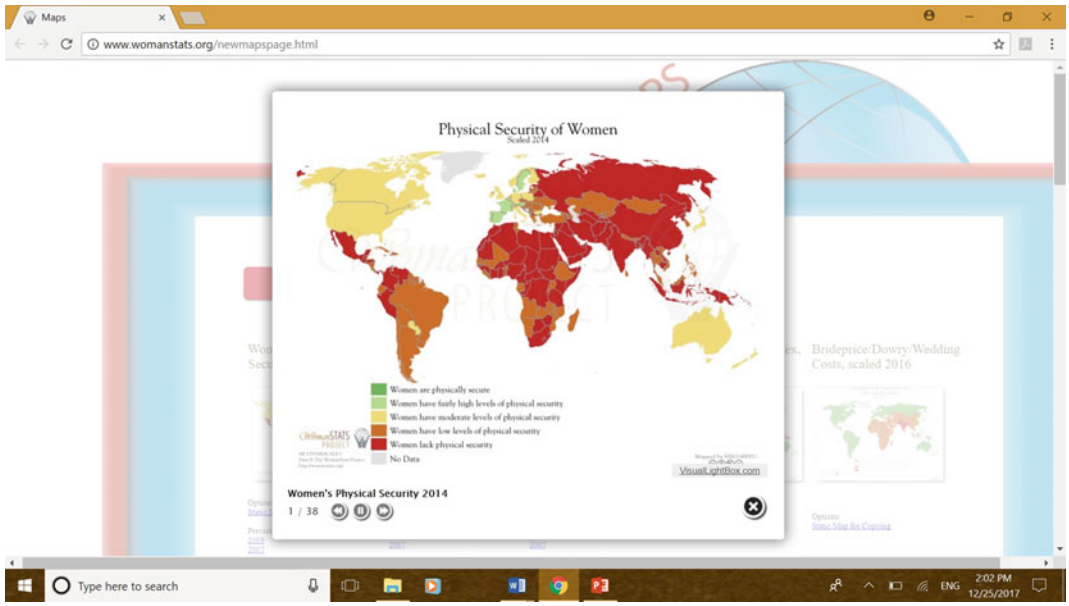

Fig. 14.12 Map on website for visualisation of women-related issues

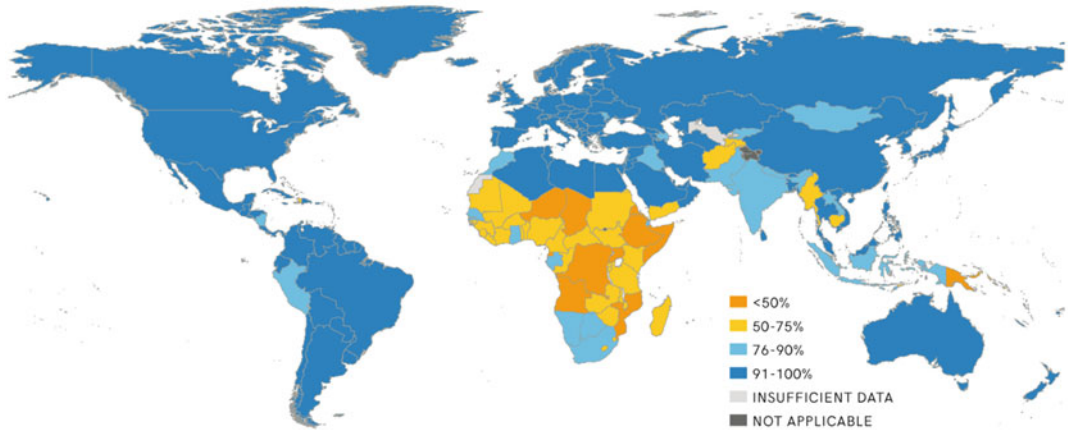

Fig. 14.13 Proportion of the population using basic drinking water services in 2015

Fig. 14.14 Web-based visualisation of drinking water, sanitation and hygiene

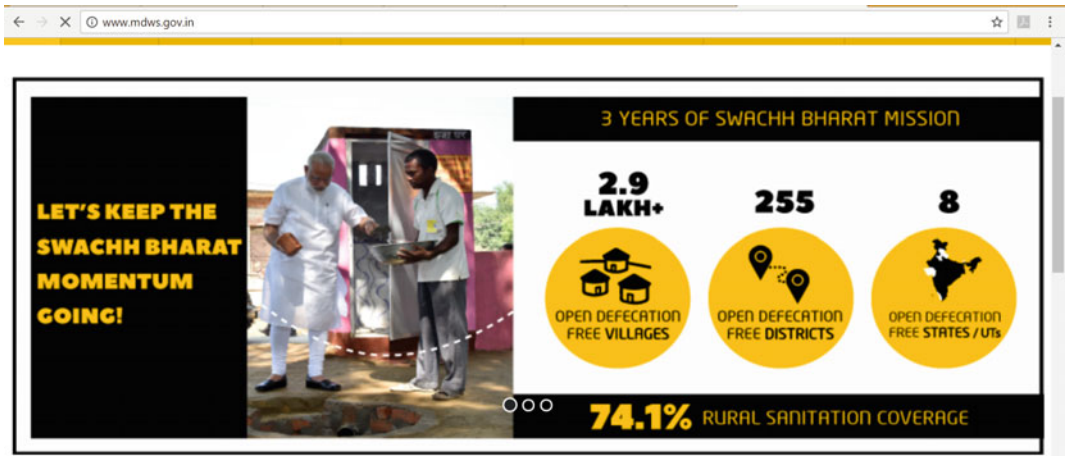

Fig. 14.15 'Swachh Bharat Mission in India' initiated by Hon'ble Prime Minister Shri Narendra Modi

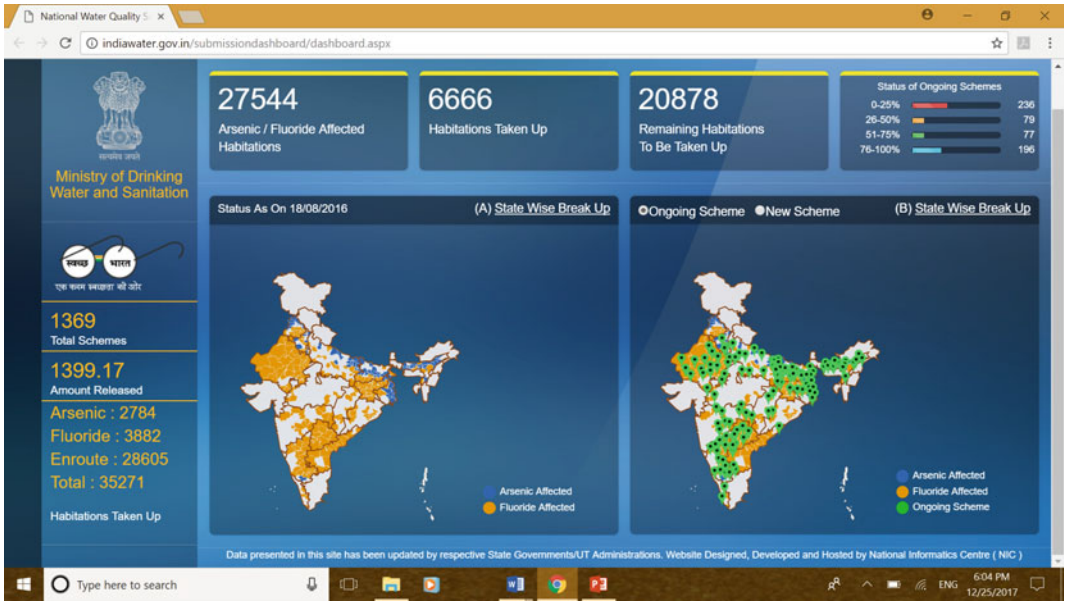

Fig. 14.16 Ministry of Drinking Water and Sanitation web portal for spatial characteristics of water-related problems (*source* https://indiawater.gov.in)

The Ministry of Drinking Water and Sanitation, the government of India, has a web portal (indiawater.gov.in) to provide information on such issues (Figs. 14.15, 14.16 and 14.17). The government of India has also initiated Swachh Bharat Abhiyan (Clean India Mission) and undertaken the task of mass toilet construction. Household toilet availability has improved from 41.93% in 2014 to 63.98% in 2017, and Himachal Pradesh, Sikkim and Kerala have all achieved 100% open defecation-free status.

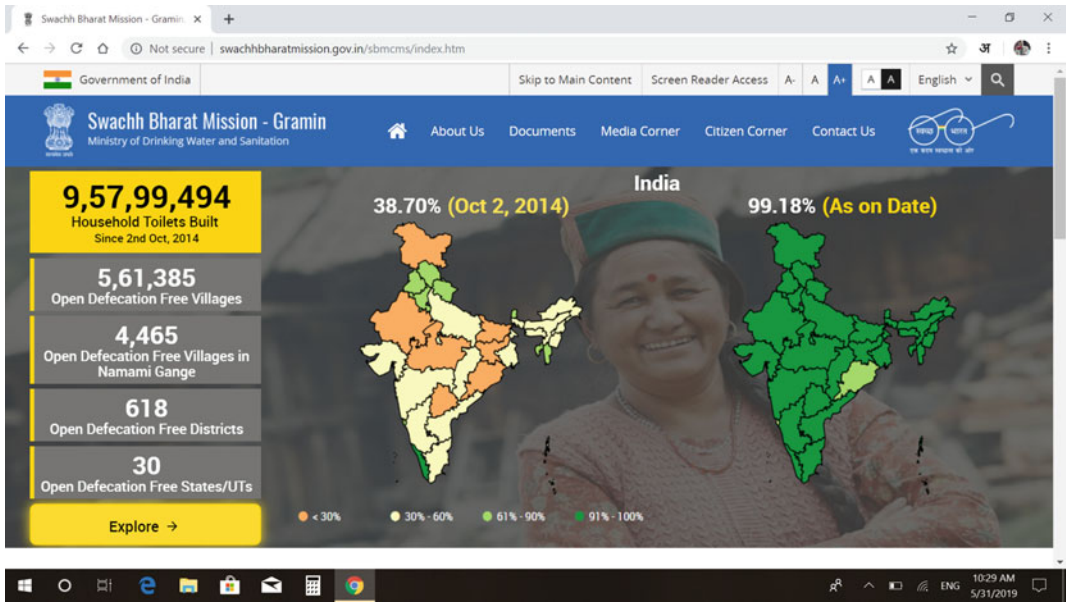

Fig. 14.17 Web portal of Swachhata Darpan

14.8 Goal 7: Affordable and Clean Energy: Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All

The main targets are to ensure universal access to affordable, reliable and modern energy services, increase the share of renewable energy and double the improvement in energy efficiency. Meaningful improvements will require higher levels of financing and bolder policy commitments, together with the willingness of countries to embrace new technologies on a much wider scale. The World Bank, International Energy Agency and the Energy Sector Management Assistance Program jointly prepared the Global Tracking Framework related to electricity through maps (Fig. 14.18). India has a vast potential for solar power generation with about 58% of the total land area receiving above 5 KWh/m^2/day annual average global insolation. It is a viable alternative for power generation among the available clean energy sources (www.ibef.org). Deendayal Upadhayaya Gram Jyoti Yojana is a Scheme of the Government of India for Rural Electrification (Fig. 14.19). The (*Sahaj Bijli Har Ghar Yojna Saubhagya*) is a web portal designed and launched to monitor the progress of household electrification in India using solar power as a good example of spatial information technology application to meet SDG targets (Fig. 14.20). The government of India has also initiated Prime Minister Ujjawala Yojana (PMUY), which aims to safeguard the health of women and children by providing free LPG gas connection to 'below the poverty line' (BPL) households. This is a clean fuel as opposed to firewood, coal, dung-cakes etc. (http://www.pmujjwalayojana.com/released-connections.html).

14.9 Goal 8: Decent Work and Economic Growth: Promote Inclusive and Sustainable Economic Growth, Employment and Decent Work for All

Sustaining per capita economic growth in accordance with national circumstances and at least 7% gross domestic product (GDP) growth per annum in the least developed countries is

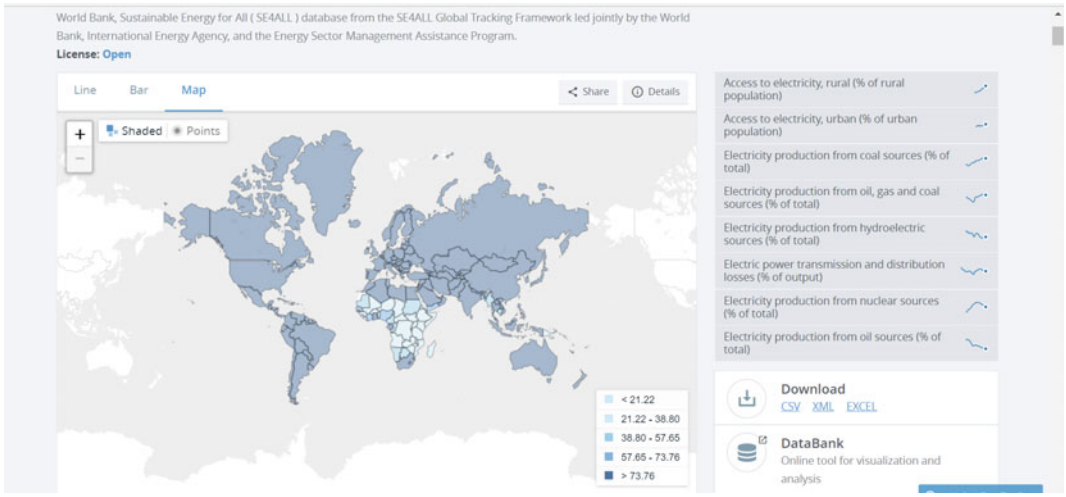

Fig. 14.18 Access to electricity (percentage of population)

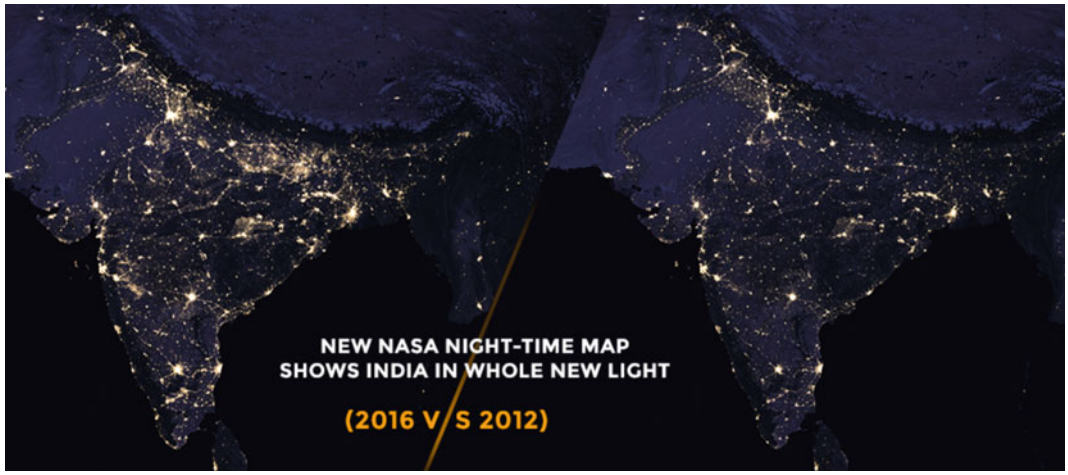

Fig. 14.19 Electricity development in India during 2012–2016 (*source* http://powermin.nic.in/)

one of the targets of SDG 8. Information about economic growth by map can show the status of the country (Fig. 14.21). Tourism is one of the world's fastest-growing industries and an important source of foreign exchange and employment for many developing countries. SDG target 8.9 is to devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products. The travel and tourism sector in the global economy continues to be very robust and seamlessly increasing. In 2017, the contribution of travel and tourism to the world GDP rose to 10.2%. Worldwide, this sector provides employment to 1 in every 10 people (Fig. 14.22).

Fig. 14.20 Saubhagya web portal (*source* www.saubhagya.gov.in)

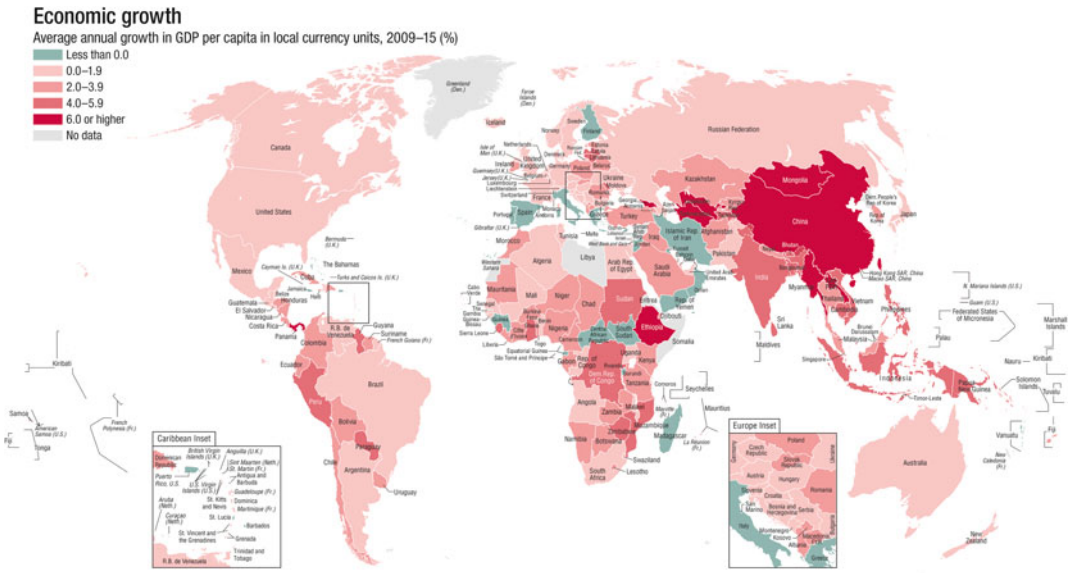

Fig. 14.21 Economic growth (*source* World Bank)

Fig. 14.22 Growth of travel and tourism industry in 2017 (*source* World Travel & Tourism Council)

14.10 Goal 9: Industry, Innovation and Infrastructure: Build Resilient Infrastructure, Promote Sustainable Industrialisation and Foster Innovation

The target of SDG 9 is to develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure to support economic development and human well-being with a focus on affordable and equitable access for all. Spatial information technology plays an important role in the development of infrastructure. The Great London Authority has developed an infrastructure map tool to explore current and future development and infrastructure projects in London (Fig. 14.23).

14.11 Goal 11: Sustainable Cities and Communities: Make Cities Inclusive, Safe, Resilient and Sustainable

The main target of SDG 11 is to ensure access for all to adequate, safe and affordable housing and basic services and to upgrade slums. This goal also targets providing people access to safe, affordable, accessible and sustainable transportation systems and improving road safety (notably by expanding public transport), with special attention to the needs of those in vulnerable situations – women, children, persons with disabilities and older persons. The Smart Cities Mission of the Government of India is a bold initiative in sustainable and inclusive development in India. The purpose of this mission is to drive economic growth and improve the quality of life of the people by enabling local area development and harnessing technology. Area-based development will transform existing areas (retrofit and redevelop), including slums, thereby improving the liveability of the whole city. New areas (greenfield) will be developed around cities in order to accommodate the expanding population of urban areas. Application of smart solutions will enable cities to use technology, information and data to improve infrastructure and services. Comprehensive development in this way will improve the quality of life, create employment and enhance incomes for all, especially the poor and the disadvantaged, leading to inclusive cities (Fig. 14.24).

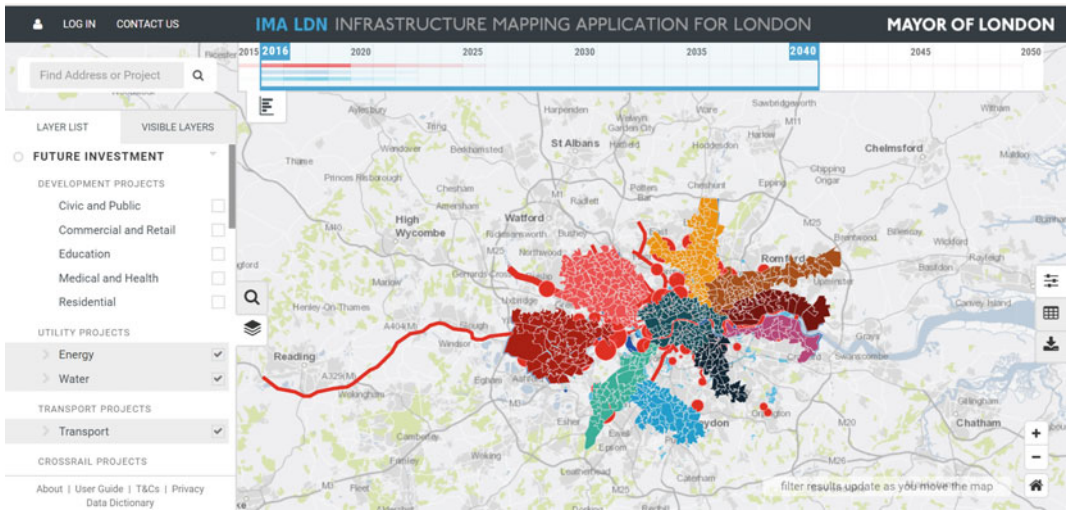

Fig. 14.23 London infrastructure mapping tool (*source* maps.london.gov.uk)

14.12 Goal 14: Life Below Water: Conserve and Sustainably Use the Oceans, Seas and Marine Resources

The target of SDG 14 is to prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution. Spatial information is always required for preventing and reducing marine pollution (Fig. 14.25). The map shows the five levels of risk from coastal eutrophication and the very high risks found in the Bay of Bengal, East China Sea, Gulf of Mexico, North Brazil Shelf and South China Sea (https://unstats.un.org).

In India, the Earth System Science Organisation-Indian National Centre for Ocean Information Services (ESSO-INCOIS) is an

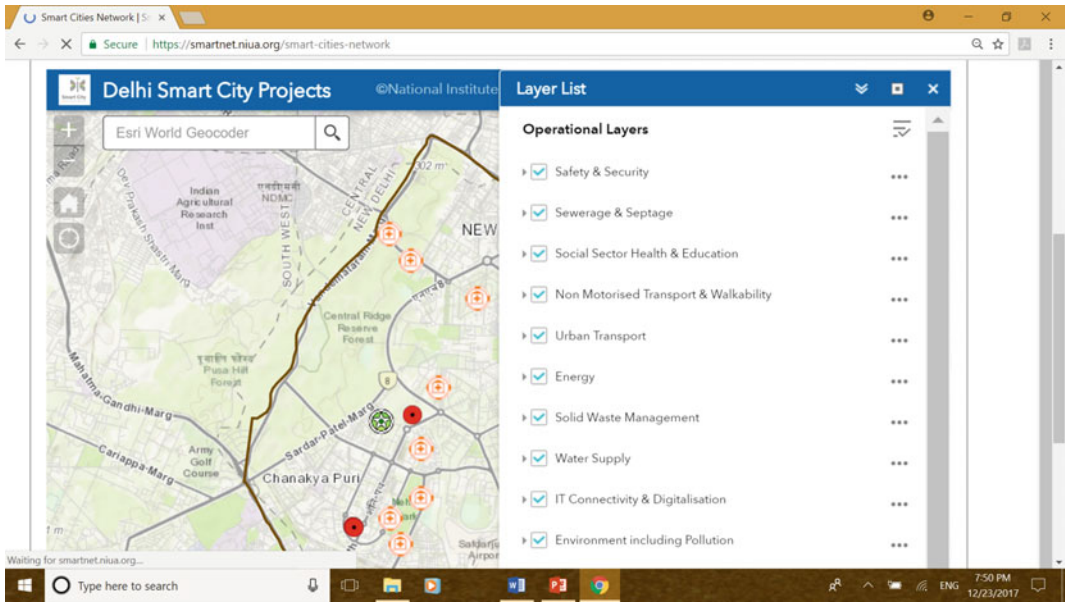

Fig. 14.24 Web portal for urban mapping (*source* https://smartnet.niua.org/smart-cities-network)

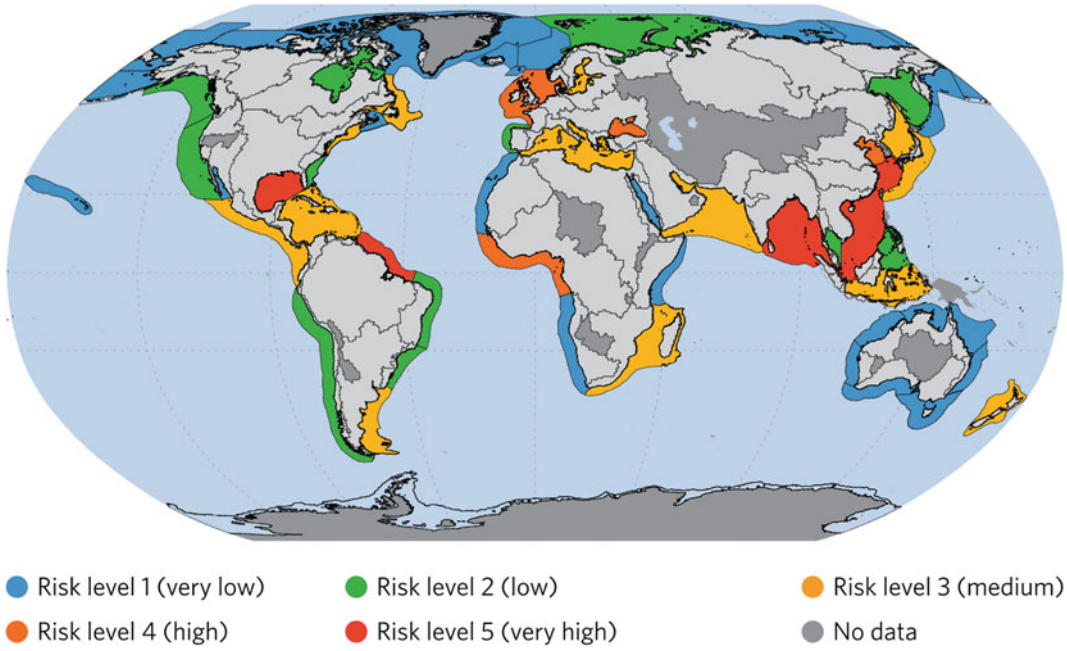

Fig. 14.25 Nutrient risk indicator categories of large marine ecosystems (*source* https://unstats.un.org)

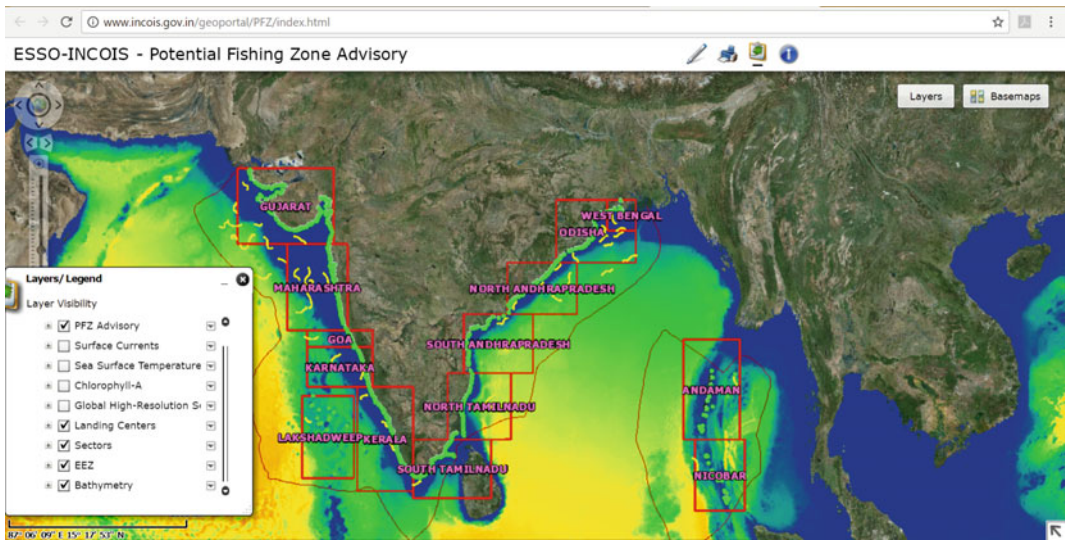

Fig. 14.26 ESSO-INCOIS web portal for ocean information (*source* www.incois.gov.in)

autonomous body under the Ministry of Earth Sciences, Government of India, that aims to provide the best possible ocean information and advice to society, industry, government agencies and the scientific community through sustained ocean observations (Fig. 14.26).

14.13 Goal 16: Peace, Justice and Strong Institutions: Promote Justice, and Peaceful and Inclusive Societies

The target of SDG 16 is to reduce all forms of violence and related death rates, end abuse, exploitation, trafficking and the torture of children. Estimates by the World Economic Forum show that 45.8 million people are enslaved worldwide. Where 4.37% of North Korea is enslaved, with the highest incidence of modern slavery, it is followed by Uzbekistan at 3.97% and Cambodia at 1.65% (Fig. 14.27). In terms of absolute numbers, India has more people in slavery than any other country, estimated at 18.3 million.

The spatial distribution of terrorism index can also be mapped to understand the impact of terrorism. The figure shows that the top five most affected countries in 2014 were Iraq, Afghanistan, Nigeria, Pakistan and Syria (Fig. 14.28).

14.14 Goal 17: Partnerships for the Goal: Revitalise the Global Partnership for Sustainable Development

The target of SDG 17 is to enhance international support for implementing effective and targeted capacity building in developing countries to support national plans to implement all the SDGs, including through North–South, South–South and triangular cooperation. For the sustainable development of the country, the Government of India has adopted a new information technology regime, its 'Digital India' programme to support good governance. Geospatial technology has proven to be an effective enabler to meet these challenges by developing technical capacity at the individual

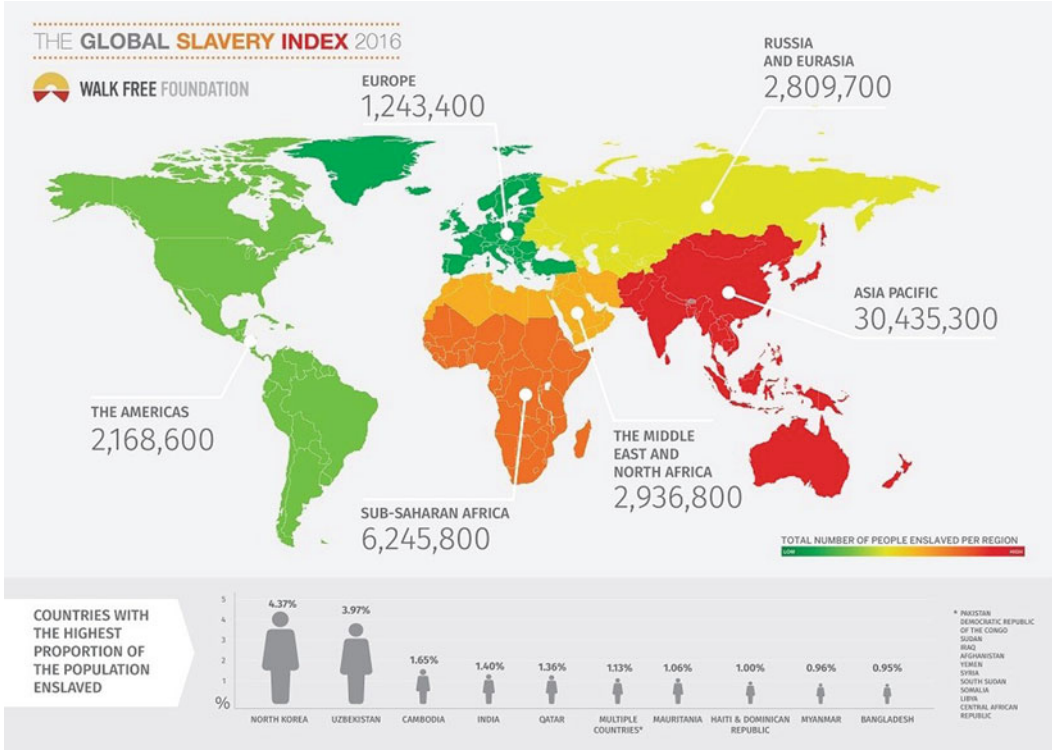

Fig. 14.27 Global Slavery Index 2016 (*source* World Economic Forum)

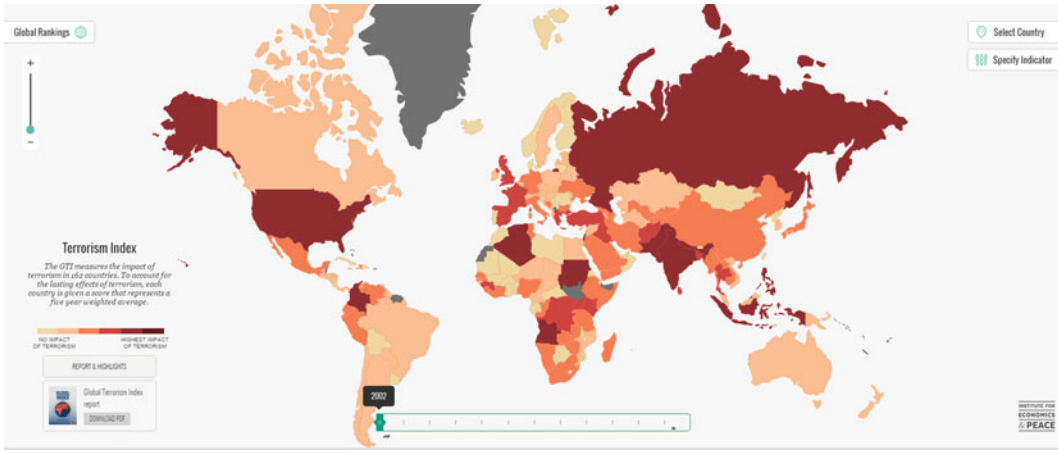

Fig. 14.28 Terrorism index, 2014 (*source* www.weforum.org)

level. Capacity building is an ongoing process and involves changing attitudes, imparting technical knowledge and developing skills while maximising the benefits of participation, knowledge exchange and ownerships. The Natural Resources Data Management System (NRDMS) programme is a multidisciplinary and multi-institutional research and development programme of the Department of Sciences and Technology, Government of India, to develop technology for integrated resource management and capacity building at the micro- to macro-levels in a spatio-temporal context.

14.15 Conclusion

Spatial information technology not only provides spatio-temporal information but is also one of the best techniques for communicating information to the general public. It has the capacity to show the spatial relationships among the features of the Earth's surface. With the help of various techniques of map visualisation, the information is made more memorable by the use of different colours and shapes of display. So we can say that a map can speak a thousand words. With modern technology, the huge amount of databases can easily store, retrieve and manage various types of spatial analysis for humankind.

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