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Three R's For Conservation of Natural Resources

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Resources are substances that are available and have values and demands for them. Several substances that are naturally occurring are extracted, purified and value-added for the economic reasons. These relatively unchanged natural resources, because of their high values or demands, make human beings industrious and even prosperous in contrast to those which are created by other human activities such as agriculture and art and cultural activities. The renewable nature of resources, either living or non-living, depends on their rates of replacement. The non-living natural resources are available almost in fixed amounts; their standing stocks are diminishing, not replaced compared to their rates of consumption. Both the renewable and non-renewable natural resources constitute the 'natural capital' that determines the wealth and status in the global economy. In the recent years, the unforeseeable increases in the demands on the natural resources have led to their depletion that has become a chief source of human social conflicts.

Human resources, the 7-billion people on this planet now, consume several other natural resources at higher rates than they could create or replace them. Freshwater, oil, natural gas, phosphorus, coal and rare earth elements are the major resources whose stocks are declining faster [1]. Though the freshwater resources are only 2.5% of the total volume of the global water resources, it is enough for the 7-billions. But they are distributed unevenly, poorly managed, wasted, and polluted. With annual water supplies dropping below 1000 m^3 per person, freshwater will be scarcer for about 1.8 billion people by 2025 [2]. The U.S. Energy Information Administration (EIA) has estimated that the global crude oil proved reserves are about 16456 billion barrels at the end of 2013 [3]. While the formation of oil reserves takes 50-300 million years, half of these reserves has been consumed in the last 125 years. The current rates of their consumption will deplete these resources by the next 46 years. Likewise, the natural gas proved reserves of 6846 trillion cubic feet in 2013 will only meet the human consumption for the next 54 years.

Phosphate rocks are formed from seabed to uplift and weathering that takes about 10-15 million years. The current reserves are about 15000 million tonnes and are concerted in their geographical distributions to China, Morocco and USA. The 'global peak P' will be around 2034, and these reserves will be depleted in 50-100 years. The world proved coal reserves of 861 billion tonnes can meet another 113 years of global coal production though the coal among any other fossil fuels has the largest reserves to production (R/P) ratio [4]. Among the rare earth elements, scandium and terbium are extensively used from the magnets in turbines to the electronic circuits. China meets about 97% of the global demand while the global reserves are not fully identified.

Ironically, what is being created massively due to the current human consumption patterns are wastes. They are of variable proportions affecting the environmental quality from at unpredictable spatial scales. Globally, rubbish is a conspicuous environmental burden by human civilization, generated faster than several other pollutants. The World Bank report suggests that the peak global solid waste generation would be around 2025, with 6 million tonnes per day [5,6]. There are seasonal, cultural and the rich-poor influences on the creation as well as the composition of wastes. Their management with a 'waste hierarchy' aims at their prevention, followed by re-use, recycling, recovery and disposal. All these options target extracting maximum practical benefits of natural resources with a minimum amount being disposed.

Life cycle thinking and assessment is critical for the extraction, purification, making of products, distribution, usage, to disposal since all products and services have environmental consequences. Waste management can then be pursued relatively easily by three R's- 'Reduce, Reuse and Recycle.' These options require human ingenuity and endeavours, and they will be as demanding as those three R's of Sir William Curtis suggested for human development. But, human beings are vulnerable even to their own thinking capabilities which are often laden with fallacies such as egocentrism, omniscience, omnipotence and invulnerability [7,8]. Probably, the 'Other three Rs' such as reasoning, resilience and responsibility as key problem solving skills are very much needed to sustain human life for long since several natural resources becoming scarcer, with wastes being generated at colossal magnitudes.

Transformation of wastes into useful and probably lesser valuable products provides new economic opportunities with science and technological underpinnings. The collection and treatment of wastes that maximise their values can make them become very important anthropogenic resources for future exploitation. Several carbon-containing wastes are now considered suitable for the bioeconomy, which involves biological feedstocks or biotechnological processes to generate economic inputs [9]. For bioeconomy, the biological agents of significance are microorganisms that are tiny and invisible to human eyes, plants and animals.

Presently, the stocks of natural capital are to be replenished or else there are risks of local, regional or global collapse of economies, based chiefly on materials and services. Both in the short as well as in the long term, high consumption rates can change the overall stock and flow of resources, with concomitant changes in their values. The conservation of natural resources is now valued more than ever before. But, the global stocks of natural assets include all living things besides water, air, soil and minerals. Native plants and animals, ecosystems and habitats deliver environmental products and benefits that are now referred to as ecosystem services and considered as capital assets to sustain and enhance the lives of all the living beings. There is still a poor understanding of the total stocks and complexities of natural living assets in their relationships with environments, including those

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of human resources. More importantly, the environmental costs or toxicities of several newly synthesized substances or wastes are yet to be ascertained.

Knowledge creation is vital for enhancing the existence of all living beings individually and collectively. The scientific research with three R's of rigor, relevance and responsiveness to the needs of practitioners provides new knowledge. For long, animal models and plant assays are routinely employed to increase the human knowledge of nature or to get information on the toxic or harmful effects of substances to humans. Like humans, animals can experience pain. Animals which possess nociceptors/receptors for detecting stimuli, pathways from nociceptors to the brain, opioid receptors and endogenous opioid substances in a nociceptive neural system, and can respond to analgesics or painkillers or even learn to avoid painful stimuli have led to reconsider their use as models for experimentation [10,11]. The 1986 Animals (Scientific Procedures) Act of the United Kingdom and the regulations of several other countries advocate three R's of refinement, reduction and replacement before experimenting with animals.

Plants can sense, respond and learn in ways that are similar to animals and humans. Plants are known to use volatile chemicals to communicate with each other. Recently, the roots of corn plants were found to generate structured acoustic emissions and frequent clicks in the region of 200-300Hz, suggesting their sensory and communicatory complexities [12]. Also, plants can learn from the experiences and acquire the learnt behaviour too [13]. As in humans where pain is experienced by calcium signal from one neuron to another, plants respond to salt by creating 'calcium wave,' from the point of perception in roots to the tips of shoots and leaves [14]. Amusingly, several medicinal plants produce human brain acting chemicals such as the alkaloids, the phenolics and the terpenes [15]. Despite the poor understanding of responses of plants and other animals to different environmental stimuli, they continue to serve as the experimental models for toxicity tests and ecological risk assessment.

Microorganisms are sensitive to the environmental stress, though not at the level of individual organisms at all times but at the community levels. In nature, microorganisms grow as multicellular communities, mainly because of their sizes. With recent advances in profiling their communities using molecular techniques, they serve as sensitive indicators of modified environmental conditions due to the presence of contaminants at higher amounts. Atlas and Hazen (2011) suggested that the oil-degrading indigenous microorganisms lessened the environmental impact of two worst spills in the history of U. S. [16]. Three R's of microbial communities-resistance, resilience, and redundancy make the testing of community functionality meaningful for ecological risk assessment. Not only to the presence of specific contaminant 'families' such as heavy metals or polynuclear aromatic hydrocarbons (PAHs), they respond to the complex mix of contaminants [17]. Ji et al. [18] demonstrated that there were long term effects of PAHs on bacterial communities. Even deforestation followed by the long-term agricultural cultivations changed the microbial community composition, with differential effects on the functional stability, relative to the adjacent native forest [19]. With microorganisms contributing to the health of all organisms and ecosystems, their responses to the environmental changes can contribute better to our understanding of the macroecology [20]. The recent report of Keiser et al. [21] which suggested the influences of historical resource conditions on the microbial community functions highlights the need for a better understanding of these communities. The native microbial resources with exceptional capabilities to degrade several pollutants and to serve as sensitive indicators as well as to remediate the contaminated environments require resolute efforts for their conservation.

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