

Integrated Approach between DPSIR, Planetary Boundaries and Sustainable Development Goals ~ towards 3Rs and Resource Efficiency

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Abstract This article explores integrated interdisciplinary environmental research, between DPSIR framework (Driving Force-Pressure-State-Impact-Responses), planetary boundaries and Sustainable Development Goals (SDGs), particularly in waste management policies and strategies i.e., 3Rs (reduce, reuse and recycle) and resource efficiency. These policies and strategies could be beneficial for mitigating human and environmental impacts on the Earth system and reaching a safe operating space for planetary boundaries. This article focuses on how planetary boundaries and 3Rs and resource efficiency policies can successfully integrate into environmentally sustainable waste management systems and achieve the 2030 Agenda for Sustainable Development Goals. In discussion and result section, this article shows the reduction of environmental impacts of unsustainable consumption and production patterns of resources is directly reflect on the sustainable resource management, particular SDG 12. Moreover, the proper and effective implementation of 3Rs and resource efficiency policies and strategies provide a vision for sustainable resource management.

Keywords 3Rs (Reduce, Reuse and Recycle), Resource efficiency, Planetary boundaries, DPSIR and Sustainable Development Goals (SDGs)

1. Introduction

Urbanization is a significant driver of environmental, economic and social changes. As rapid growth in the urban population continues, the amount of resource consumption increases, putting tremendous strain on resource use, consumption, and production patterns. Natural resources are becoming scarce with current global trends of over-consumption and production patterns. The definition of sustainable development reflects as [1] 'development that meets the needs of the present while safeguarding earth's life-support system, on which the welfare of current and future generations depends'. Making progress on sustainable development requires an adequate understanding and knowledge of current environmental (waste management and pollution), economic (gross domestic product growth and business opportunities) and social (lifestyle and behavior of human beings) issues.

Many goals and strategies that have developed on the pathway to achieving the 2030 Agenda for Sustainable Development. One of the best examples is the concept of planetary boundaries proposed by Rockström [2] that defines

nine global tipping points that would be irreversible if transgressed by human activities. The nine categories are climate change, the rate of biodiversity loss, stratospheric ozone depletion, ocean acidification, biogeochemical flows, land-system change, freshwater use, atmospheric aerosol loading and chemical pollution. The three boundaries [2] have already crossed (climate change, loss of biodiversity, and nitrogen and phosphorus cycles) and the remaining six are reaching their thresholds. These boundaries exemplify the planet's biophysical limits and 'safe operating spaces' for humans to live within. The framework represents earth, human-driven environmental pressures and an easy to understand the link between anthropogenic activities and the natural environment.

Rockstrom [2] place great emphasis on these boundaries and their significance towards human survival. Besides, Rockstorm notes how human activity has exceeded the capacity of some of these boundaries. Rockström [2] emphasized the importance of these boundaries to human survival, and how human activity has exceeded the capacity of some of these boundaries - an occurrence which poses a significant risk to human progress. Saunders [3] discussed the implications of planetary boundaries to conceptualize sustainable development, with attention to the aspects of development, equity, and institutional process. As Steffen [4] pointed out, continuing in this direction has a high probability of leading the earth system to a different state,

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one that is likely to be much less hospitable to the development of human societies. Therefore, sustainable development, with an emphasis on 3R and resource efficiency policies that integrate the planetary boundaries into decision making, must be achieved.

3Rs, resource efficiency technologies, and policies are one of the most viable strategies available, especially in the context of waste management, for achieving sustainable development discussed during the annual Regional 3R Forum in Asia and the Pacific [5]. 3Rs and resource efficiency related policies play a significant role to curb increasing environmental, social and economic burdens and to control the transgression of planetary boundaries. In addition, waste management issues very well embedded within the Sustainable Development Goals (SDGs), either explicitly or implicitly, in more than half of the 17 goals [6].

The 2030 Agenda of Sustainable Development Goals comprised 17 goals and 169 targets [7], and Goal 12 is to ensure responsible consumption and production patterns, which lies at the heart of 3Rs/resource efficiency policies. This goal and its targets are tightly linked with the decoupling of economic growth from environmental degradation, national action plans for sustainable consumption and production, material stock analysis, and emphasizes the sustainable use and management of natural resources. As Hoornweg [8] address, “An urban approach to planetary boundaries”. This address proves that city residents drive the world’s material and energy flows. According to their association with global environmental impacts, it leaves them in a vulnerable state. Hence, at a city level, the implementation of 3Rs, resource efficiency policies and technologies can be used for reducing environmental impacts in effect not to cross the limits of planetary boundaries.

This paper purpose to promote a discussion on how planetary boundaries and 3Rs and resource efficiency policies can successfully integrate into environmentally sustainable waste management systems. The first section of this paper will discuss the concept of 3Rs and resource efficiency and the potential of the environment and economic benefits it offers. The second section will discuss the significance of future steps in achieving sustainable development goals. It is critical to examine the integrated study of planetary boundaries with 3Rs and resource efficiency strategies and policies.

2. Integration between DPSIR Framework, Planetary Boundaries and SDGs ~3Rs/Resource Efficiency Policies

2.1. Sustainable Use of Natural Resources

Material extraction at a global level increases each year tremendously. The unsustainable patterns of extracting, transforming and consuming natural resources are exerting

enormous pressure on the environment such as by exceeding natural capacities of absorbing societal emissions, by depleting natural stocks, by changing natural landscapes, and over-consumption of freshwater. The term natural resources refer to oil, minerals, forests, water and fertile land that occur in nature and exploit for economic gain [9]. Dittrich [10] illustrated in a “business as usual” scenario that humans would require around 180 billion tonnes of different natural resources (biomass, minerals, fossil fuels, and metals) in 2050, which is growing by a factor of 2.7 compared to today’s levels.

The unsustainable consumption and production patterns lead to increase water and air pollution, land and forest degradation, and excess waste generation. The economic growth will have to be decoupled from resource use and environmental degradation so that inclusive socio-economic development can be sustained [11]. The modern economies are aiming for the decoupling of economic growth from resource consumption while increasing the quality of life through the productive reuse of waste and minimization of waste disposal. Reducing overconsumption and waste of natural resources on one end and providing secure access to natural resources on the other end will have to be addressed simultaneously. The proper management of resource extraction, use, and the adequate disposal of waste are essential tools for sustainable development and towards attaining the ‘safe operating space’ threshold in which planetary boundaries not transgressed. The efforts to realize this operating space requires significant investment and development in 3Rs and resource-efficiency policies that produce benefits associated with decoupling and the sustainable use of natural resources.

2.2. Benefits Associated with 3Rs and Resource Efficiency Policies

3Rs and resource efficiency policies seek to enhance the quality of life by minimizing waste generation and resource extraction. The concept of resource efficiency is an alternative to the current unsustainable “business-as-usual” style of production and consumption. Through industrial symbiosis, green technologies (which requires less raw materials), and utilization of waste resources, 3Rs, and resource efficiency policies can reduce the amount of natural resource use by re-using the waste in production processes.

Additionally, by reformulating the waste, the number of natural resources extracted as a primary input to production can be reduced. It creates numerous co-benefits such as green economy, green jobs, and other business opportunities. 3Rs and resource efficiency policies can reduce pollution, and the impacts on climate change, nitrogen cycle, freshwater use, land use change, and biodiversity—six of the seven biophysical indicators used for evaluating the sustainable development of cities as specified by [8]. 3Rs and resource efficiency policies have the potential to alleviate the harmful impacts through more sustainable use of natural resources.

2.3. Integration between DPSIR and SDGs

Each of the 17 Sustainable Development Goals has accompanied targets and indicators by which they can achieve and using the DPSIR framework offers a clearer understanding of how each of the 169 SDGs targets can be categorized. The DPSIR framework was developed by the European Environment Agency to describe societies' interaction with the environment. This framework would be helpful to assess the SDGs, enable the classification of targets into the following categories of factors. Driving forces-the socioeconomic and demographic related changes, Pressures- the anthropogenic factors, State- natural ecosystems and resources, Impacts-environmental change factors and finally Responses- the policy actions [12]. The applicability of DPSIR model helps to assess the decoupling between economic growth and waste generation and environmental threats [13].

Figure 2 shows each of the 169 targets of the SDGs is referenced with a '1' or a '0' to indicate its interaction in the environment. Most of the targets are inclined towards Pressures (mainly the anthropogenic factors) imposed on our environment and followed by the Driving forces (socio-economic factors) and the Impacts. The State and Responses factors, on the other hand, have minimal effect on the overall SDG targets. As highlighted in Steffen [4], the planet is almost going beyond its safe operating space primarily attributed to human activities. The earth is home to society and therefore makes it vital for humans to protect it by limiting the use of natural resources, GHG emissions, and other environmental pressures [14]. To this extent using the DPSIR framework and the planetary boundaries framework will offer a viable means to assess the SDG targets and by extent the 2030 Global Agenda.

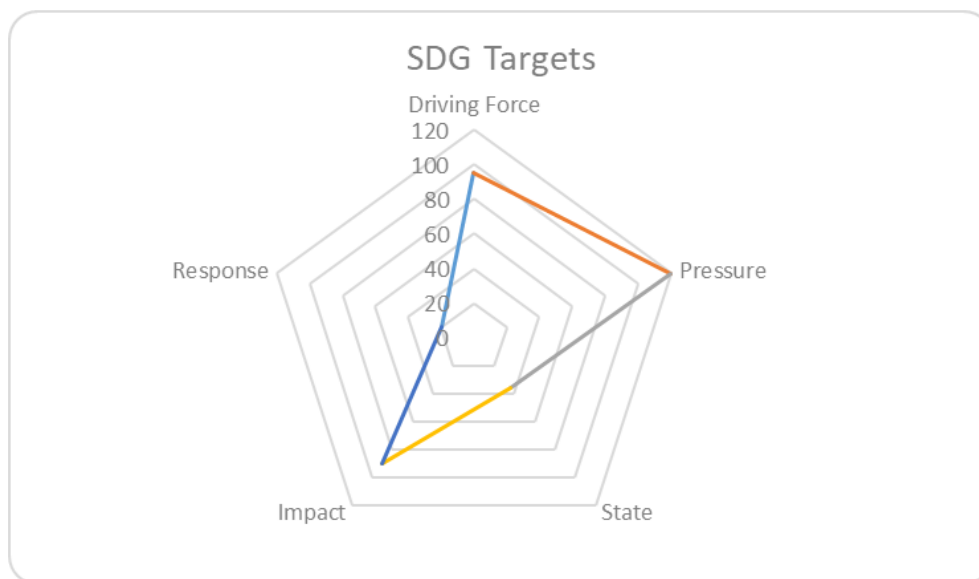


Figure 1. Integration approach between DPSIR framework and SDGs

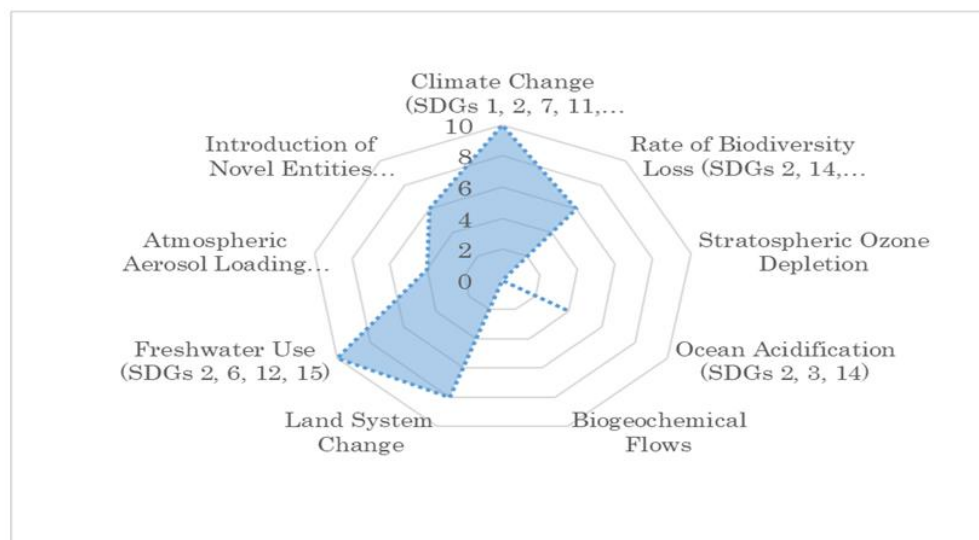


Figure 2. Integration between Planetary boundaries and Sustainable Development Goals (SDGs)

Figure 2 is a graphical representation of the relationship between the SDGs and planetary boundaries. Each time a planetary boundary was mentioned, either explicitly through the wording of the SDG or associated targets, the planetary boundaries received one reference. For example, neither biogeochemical flows nor stratospheric ozone depletion explicitly mentioned throughout the 17 SDGs or any of the associated targets. Climate change, on the other hand, was explicitly referenced a total of 10 times throughout the SDGs and associated targets, therefore, it received a total of 10 references. Not only does this figure demonstrate the connection between SDGs and planetary boundaries, but it also emphasizes which planetary boundary and SDGs are most closely related. Located in parentheses after each planetary boundary, is a list of the specific SDGs that referred to the planetary boundaries.

By making the connection between SDGs and planetary boundaries, it is possible to connect the planetary boundaries and resource efficiency. Both resource efficiency and the planetary boundaries are slowly incorporated into the SDGs, and therefore into one another. It is likely there are plenty more implicit references to the planetary boundaries in the SDGs, however, for this paper, only explicit references were used.

3. Integration between 3Rs, Resource Efficiency and Circular Economy

The circular economy represents a fundamental alternative to the currently predominating linear approach that is based on unlimited resource extraction and disregards the natural resources of planetary boundaries. A circular economy is a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing energy and material loops. This can be achieved through long-lasting design, maintenance, and repair, reuse, remanufacturing, refurbishing, recycling, and up-cycling [15]. The circular economy presents an alternative approach to the traditional linear economy model of take-make-consume-dispose, which presumes the availability of infinite and cheap resources to continuously create products with a finite lifespan with unlimited demand. Worldwide there is a growing recognition of circular economic development approach as one of the key drivers towards achieving the 2030 Agenda for Sustainable Development and the underlined SDGs. The resources are finite, energy costs are increasing, and products end up in landfills where it pollutes the environment. The assumptions a linear extractive economy are predicated on is not exactly representative of the reality where humanity is consuming and disposing beyond planetary boundaries [4]. The systems of production and consumption need to recognize limitations and transition to sustainable practices. As circular economy aims to reduce waste, implementing its principles into existing economies would increase land productivity [16] and

resource efficiency. The principles of circular economy can be used as a tool for climate change mitigation, crafting a more resilient economy, and facilitating a socially just and inclusive society [17]. The United Nations is currently working with partners to incentivize circularity in order to shift to more sustainable and resilient economies and societies [18]. A resource efficient and circular economic development model calls for a transition of the management of natural resources with a progressive minimization of waste in both consumption and production processes through a range of 3R policies and measures. 3Rs and circular economy, and waste management as approaches and tools that can support better environmental performance.

4. Discussion

The actual progress towards sustainable development will ultimately depend on how to manage the planet's natural resources responsibly. The progress towards sustainable development ultimately depends on how the planet's natural resources managed. It is vital that the reduction of environmental impacts of unsustainable consumption and production patterns of resources is reflected within sustainable resource management. The focus should be on the effective use of natural resources in an equitable and environmentally responsible manner. The main aim is to provide linkages between planetary boundaries and sustainable development goals. Various topics which can then be used to assist policymakers in making appropriate and informed decisions regarding the various pressures humankind have imposed on Earth systems. It emphasizes the potential benefits of 3Rs and resource efficiency policies and technologies in mitigating the numerous pressures on the planetary boundaries. This article focuses on the transgressing balance between planetary boundaries and 3Rs and resource efficiency which helps to promote the sustainable use of resources, sustainable waste management, and provide green jobs and a better quality of life. In addition, the proper and effective implementation of 3Rs and resource efficiency policies and strategies will provide a vision for sustainable resource use and economic transition while reducing environmental burdens on humankind and its societies.

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