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Clusterization as a Tool for Sustainable Development

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ABSTRACT: Increasing city limits, rural-to-urban migration and escalating growth of resource-intensive manufacturing sector is leading to burgeoning of our cities' footprint and over-burdening of the available bio-productive lands, thus having manifold impacts on the environment. The recent development programs of Government of India like Smart city, AMRUT, Model Villages etc. strategize to push the nation towards the path of better development and smart environment. In order to achieve this objective, the concept of cluster development or 'Clusterization' may be explored as a possible development tool.
This paper tries to put forward the concept of clusterization focusing on protection of environment, optimum use of resources and a promising economy though promotion of innovative cluster development models. The paper aims at exploring how clusterization can be an effective development policy tool so as to ensure sustainable growth of a settlement. The key stages of analysis involves critical examination of different development sectors like Industry, Agriculture, Transportation, Water Supply etc. in light of 'Clusterization'.

I. INTRODUCTION

During the last few decades, it has become evident that we can no longer think of development in isolation from environment. Urbanization is inevitable and the need of the day, however the current trend of development is progressing at the cost of our environment. Along with other developed countries, India is also at the edge of facing an ecological crisis with our natural resources getting depleted day by day. More than half of the world's populations are expected to live in urban expanses, cities and their hinterland will occupy an additional 1.2 million square kilometers, thereby tripling in size. This rapidly increasing population, unplanned and uncontrolled growth are adversely affecting and destroying the health of the society, leading to pollution and high consumption of resources, ultimately placing a great deal of stress on the environment. Planning Commission of India in their study mentions that industrialization is the economic engine pivotal for the socio-economic development of a country contributing nearly 50-60% to the nation's GDP. However, in India the rapid development of resource-intensive industries is adversely affecting the quality of our environment either by unwise use of natural resources or by increasing pollution.

Over the years, various local and regional level problems have arisen due to industrial development, agricultural activities etc. many of which may be linked to mismanagement of natural resources. The need of the day is an alternative future strategy for India, wherein we try to sustain a healthy economic growth rate without compromising on our natural resource wealth, by incorporating a comprehensive resource-efficient plan into the economic processes and planning of the country.

II. CONTEXTUAL BACKGROUND

India is transforming – first green revolution followed by industrialization, liberalization and globalization of our economy and now smart development. For proper integrated development of our society, land is required for cropping, forest, recreation, transportation, wildlife etc. but its availability is reducing day by day. Green revolution claimed increase in net income of farmers once they adopted the more responsive seeds and fertilizers. But recent studies showed another trend, which is, outlays for fertilizers and pesticides is going up faster than yields. Because farming methods that depend heavily on chemical fertilizers do not maintain the soil's natural fertility and because pesticides generate resistant pests, farmers need even more fertilizers and pesticides just to achieve the same results.

Thus this incremental shift has led to more industrialization to support the agricultural sector. Our study of few industrial cities in India has shown how unplanned and haphazard exploitation of resources have caused negative effect on environment and deteriorated the quality of life of its citizens. Development is leading to a scenario where the biologically productive land is declining in India and thus deteriorating the overall bio-capacity. On the ecological footprint indicator, although India is an ecological debtor, its ecological footprint overshoots the bio-capacity – a deficit situation.

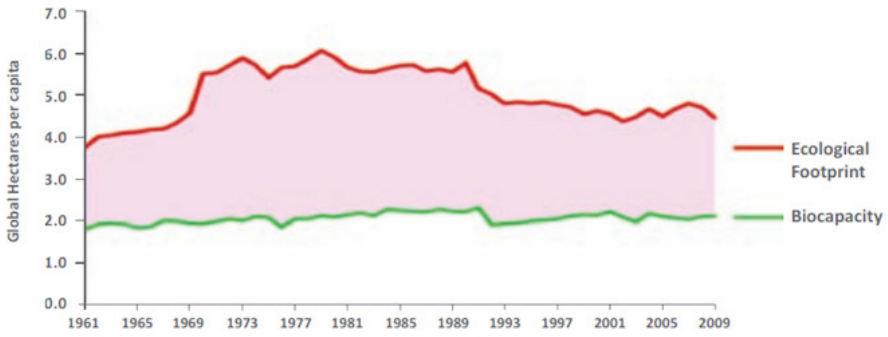

Fig. 1. Ecological Footprint and Bio-capacity of India (IGEP, 2013).

Hence, even as material demand and material productivity influence and shape the challenges confronting India, and the way it deals with these challenges regarding the use of its resources, the country would be wise not to follow the path taken by developed nations in the past, especially in the context of exploiting its natural resource base. It may make more sense for India to adopt ways to save, reuse, and recycle resources, and thus become resource efficient, right at this historical juncture of its growth story before it starts resembling the Western economies, which possess greater economic wealth but have less sustainable wealth.

To improve the condition of Indian cities, Government of India has come up with various schemes, as a way for better development like SMART City Mission, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Housing for All, Model Villages etc. These are big steps for urban India and its development agenda, which focus on re-densification of cities, providing adequate infrastructure supply, waste management but the aspect that requires actual attention is the natural environment in the cities, which gets missed out often. Latest programme of smart development strategize to push the nation towards the path of better development and mentions of 'smart environment'. But this component lacks clarity, other than the indication of use of ICT. India needs to look for new ideas surrounding the reduction of emissions & resource consumption in its cities and at the same time check how efficiency & success can be ensured in the various environmental interventions at different levels. In order to achieve the objective a 'Rapid, Sustainable and Integrated development' of India, the concept of cluster development or 'Clusterization' may be explored as a possible development policy tool.

III. WHAT IS CLUSTERIZATION?

There is no universally established definition for 'cluster' or 'clusterization'. The cluster concept is a powerful metaphor used by policymakers throughout the world. Cluster-based development approaches are gaining popularity, for designing the economic development policies of regional and national economies. Experts across the world tried defining cluster as per their respective national scenario and economy. The concept of cluster was greatly popularized in 1990s in the writings of Harvard Professor Michael E. Porter, where he defined cluster as 'Geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries and associated institutions in particular fields that compete but also cooperate and above all linked by externalities of various types'. United Nations Industrial Development Organization (UNIDO) defines industrial cluster as: "Geographic and economic concentration of manufacturing activities which produce and sell a domain of interrelated and complementary products and having common problems and opportunities".

'Cluster' development may improve the factor conditions, the inputs that firms need in their operations, such as specialized labour and skills, infrastructure, technologies, research, knowledge etc. The greater concentration leads to synchronized investments and innovation within the cluster, and also prospects for cooperation in this environment. 'Cluster' can be understood as a man-made ecosystem created, where the concept followed is the similar to the natural ecological concept.

'Clusterization' is formation of clusters or 'Cluster Development'. Clusterization shall emphasize the relationships and social-ties among the various sub-sectors in the cluster population. Clusterization should facilitate in closing the gap between supply and demand of resources along with the optimum use of the available resources. In 'Clusterization', it is important that 'clusters' consist of a variety of activities - a heterogeneous mix - in order to make the value of the cluster bigger and life cycle of clusters significant. There is no ideal best-practice for 'Cluster-development'. Every effort of 'Clusterization' is to be created taking into account the unique strength of the sector or the region or both, as well as the desired outcomes. In this context, 'Clusterization' may be defined as an ecosystem of geographically proximate and sectorally –connected concentration of associated activities linked by externalities of various types – common strengths, weaknesses, opportunities and threats – and where resources can be shared such that there is a sustainable use of the accessible resources.

IV. SUSTAINABILITY & CLUSTERIZATION

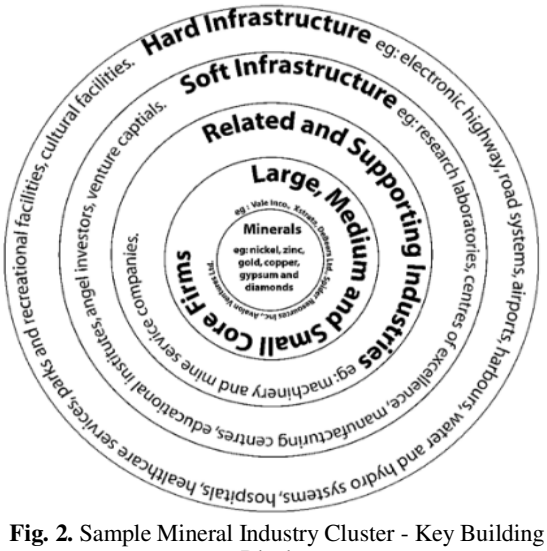

Fig. 2. Sample Mineral Industry Cluster - Key Building Blocks.

The Brundtland Commission Report (Our Common Future, 1987) put forth one of the most popular definitions of sustainable development - "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This widely discussed 'Sustainable development' is about economic activity in an environmental and social context. Clusterization can be understood as based on the principles of ecology, which deals with the mutual relations between organisms and their environment. Development of clusters with such concept will be a set of elements, perceived as a whole, inter-related in a controlled fashion. The behavior of this system results from the interaction amid the set of elements and between the system and its environment.

This forms a basic formwork for the 'smart environment' which is envisaged through the 'smart city mission' wherein high quality, optimal and efficient management of natural resources is foreseen to be promoted. The 'smartness' in the environment should be reflected through its green and sustainable development model, which is having very minimal impact on the natural environment of the smart city as well as the effective and efficient use of the resources, avoiding wastage or under-use. Formation of clusters, as for 'smart environment', helps in achieving sustainability through retrofitting the existing conditions of the environment along with technological interventions – a resilient and responsive environment. Curitiba, the capital and the largest city of the Brazilian state of Paraná, is one such city which has been re-planned on the principles of sustainability where emphasis was laid on integrated planning - social, economic and environmental - making the city a showcase of ecological and humane urbanism. In Curitiba industry is planned around the idea of 'industrial ecology' - the careful 'Clusterization' of industries so that their activities support each other, sharing heat or transport and forming a flow of materials, the waste of one industry being the raw material for another.

The complete system, i.e. the cluster, will not only include environmental components but also include services, agricultural, manufacturing as well as infrastructure such as recycling facilities, energy utility, water transmission facilities, water treatment, sewer systems, wastewater treatment facilities, transportation systems and so on. In 'Clusterization', as mentioned, this heterogeneous mix will increase the value of the cluster even more and further make the life cycle of the cluster significant.

With the concept in place, it is also important to view the system in such a way that it integrates and balances environmental, business and economic development. Clusterization, aims to construct comprehensive results, often simply incorporating discrete proven constituents into holistic design concepts for possible implementation, and hence may be treated as a multifarious, whole system challenge. Clusterization formula will need to pull together information from multiple sources to improve the citizens' quality of life. This mass of information will help to deliver high quality services to their citizens – from security and transport to energy, sanitation, water and healthcare.

In order to ensure sustainability, in the long run, each cluster is expected to integrate all city services. It should allow the users to work together to manage daily operations and crisis situations and thus becoming a valuable tool for long term urban planning. The clusters developed through the clusterization approach need not be of repetitive nature, but can have its own personality that allows it to behave autonomously. Based on the 'smart' method of development, these clusters will be in a constantly iterative upgrading process that targets to increase the environmental footprint, economic performance and social responsibility – the pillars of sustainability.

V. MODELS OF CLUSTER DEVELOPMENT

Already confronted with increasing pressure on space availability and services, settlements, especially our cities, are reconsidering their strategic primacies and planning for a model of development that is more sustainable, smarter and more creative. Clusterization or developing a settlement in a cluster form will help bringing in 'compactness', a term which is extensively endorsed as the sustainable urban form demonstrating a normative solution – an antidote - for a majority of urban problems. Or in other words, clusterization helps achieve greater energy efficiency and less pollution, preserve land through higher built densities, enable citizens to live closer to commercial and work spaces, and to use sustainable transportation means – network and mode - apart from encouraging social mix and people's interaction and environmental gains. Sectorally, the approach towards clusterization may vary. In this paper, after critical analysis of the different development sectors, we shall discuss sectoral models of development for Industry, Agriculture, Water Supply, City Planning and Transportation in light of 'Clusterization' as a tool to ensure sustainable development.

A. Industry

Industrialization plays a key role in nation building for emerging economies like India. According to Wilbert Emoore and G. R. Madan, this industrialization is a much broader process of economic development which has in view the integrated development of all other sectors, i.e. agriculture, power, transport and other services (Mondal, 2007).

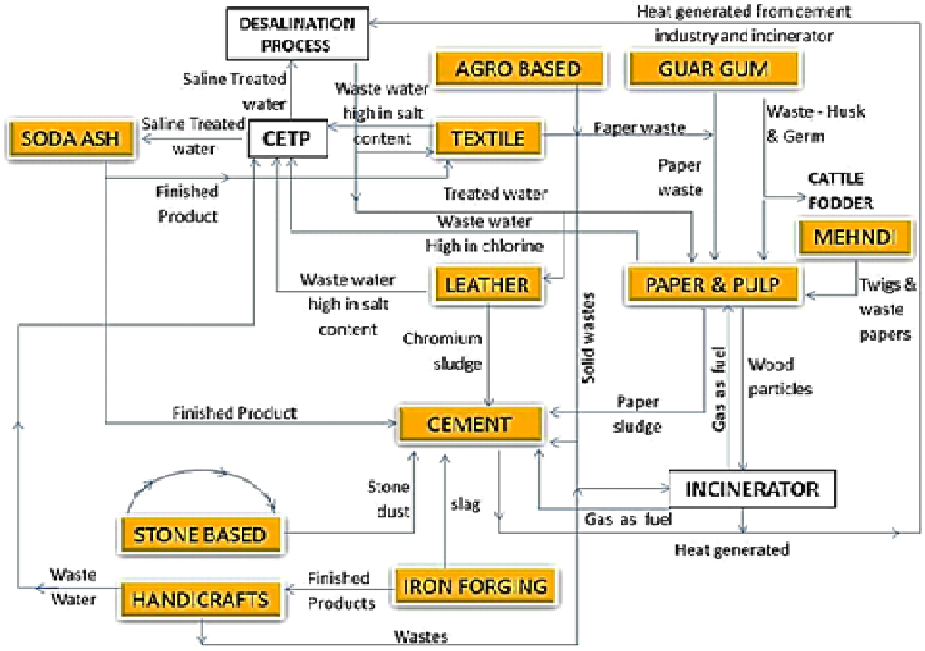

Fig. 3. Proposed Industrial Cluster in Pali, RJ based on Industrial Ecology concept. (Singh P., R.R., 2015).

Industrialization, however if not properly planned, is associated with environmental risks caused by uncontrolled consumption of natural resources, pollution and disasters. India is looking forward to achieve 'Rapid Ecologically Sustainable Industrial Growth 'by adopting strategies such as – mainstreaming and promoting green business, protecting natural resources by reducing wastage, recycling and reusing the waste to ensure the long term availability and usefulness of natural resources. In case of industrial development, the concept of clusterization gives way to frame development policy following the guidelines of industrial ecology. To demonstrate the concept of clusterization at the industrial level, the city of Pali in Rajasthan, India, classified as a critically polluted industrial area as per the CEPI, has been taken as a case example. The concept has been worked out for the industrial estate at Pali (see Figure3), after detailed study of material and energy flows through industrial systems. The industries as listed in the flow-diagram include existing industries and proposed ancillary industries. Here, the clusterization has been envisaged taking into account the raw-material requirement of each industry and the products, by-products and wastes generated by each industry. The model can run smoothly only if all the industries are clustered at an easily accessible distance. The success of such clusters lies in the easiness in provision of basic services by the competent authorities for industrial development and efficiency in service delivery of the industries in the cluster.

B. Agriculture

Agricultural Sector in India presently employs about half of the population, including 70% in rural areas, and in the five decades after start of the 'Green Revolution' India's food grain production has increased fivefold. However, the issue of food security still haunts the Indian society - India's hunger and malnutrition levels are still extremely high. This may be attributed to the great inefficiencies that remain within the agricultural sector including the large scale conversion of agricultural land and shift from agriculture to other sources of livelihood. Present day agriculture in India is not so profitable, as per a survey of persons involved in agricultural practices conducted recently in various parts across the nation by the many agricultural research institutes in India. And this also points out that the worst affected are the small and marginal farmers. About 67 percent of India's agricultural land is held by the marginal farmers with land holdings below one hectare (1 Ha.), against less than 1 percent in large holdings of 10 hectares and above, as per the most recent Agriculture Census.

Increasing the productivity of the small farmers is the answer for the rising population and the ever-rising food requirement. The future of Indian sustainable agriculture is dependent on the performance of these small and marginal farmers. Research point out that output is generally low and operating expenses comparatively high for small farm land holdings. Coupled with this are other problems like credit and indebtedness, land titles and tenancy issues, backwardness in skills and education, lack of knowledge of technology and, globalization challenges and climate change. Moreover, Indian small and marginal farmers, individually, cannot possibly afford to have heavy farm equipment, extraneous inputs and hired workers to increase their farm yields.

Interestingly, farmers in parts of Kerala and in Punjab have organized themselves into smaller SHGs (Self-Help groups) and this has helped them increase their production levels over the years significantly. Or in other words, though clusterization of the farm lands and efforts this change could be brought about, the same which can benefit almost all farmers across India. Here, clusterization can be seen as the clusterization of land, finance for input, farm labourand heavy farm equipment – common clustered resources - which help in faster and efficient agriculture. This successful model can be replicated in other parts of the country through spreading awareness by the respective local self-governance institutions.

C. Water Management

Water supply distribution and management system is one of the most critical infrastructure in a city, which must be sound and efficient for the long term growth of the city. With populations in cities growing, it is inevitable that water consumption will grow as well. Cities affect and are affected by changes in hydrological regime caused by urbanisation. Also, water bodies are important as habitats for wildlife and from the point of view of their impact on climate as they help to cool air and stimulate air circulation. Water bodies in cities are today under strong pressure due to expansion of built-up areas, uncontrolled land and water-use and pollutant discharge. Rivers are polluted in particular by waste water and agricultural activities whereby the rivers receive organic compounds, nitrates, phosphorus, ammonia etc. Groundwater is also threatened by excessive use and contamination.

The need of the hour is water and wastewater infrastructure that ensures this priceless resource, and the energy used to distribute it, is managed effectively – a sustainable system. As settlements look to achieve sustainable water supply, one available option is through clustering of activities based on inter-dependencies and water consumption.

The same have been explained taking an industrial cluster in Pali, Rajasthan, India, where detailed studies have been carried out. This is a water-scarce area characterized by harsh geography and climate. The total industrial water supply, within the given cluster (see Figure 4), required is 10.05mld of which more than 25% water requirement can be managed through efficient clusterization of the industries and application of effluent treatment and available (best-practice) re-use technologies.

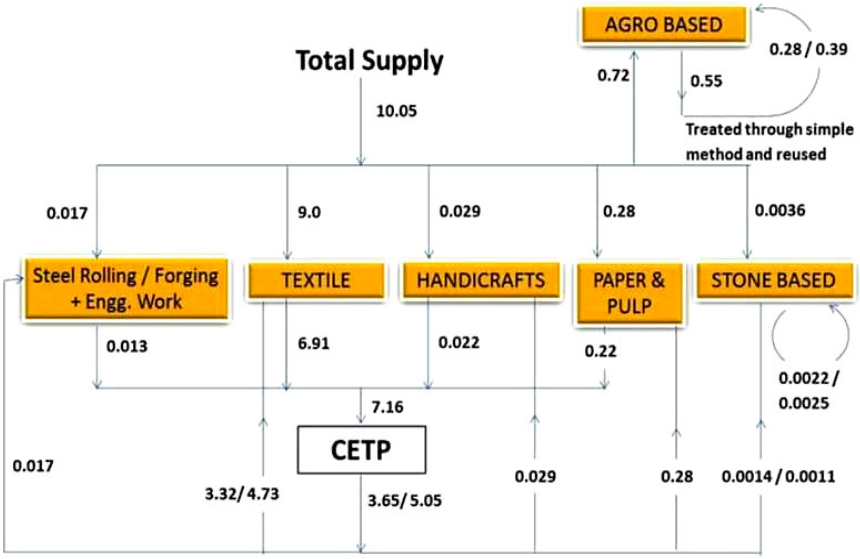

Fig. 4. Water Balance chart for proposed Industrial Cluster in Pali, RJ. (Singh P., R.R., 2015).

Another possible water management technique achievable through clusterization is rainwater harvesting. Harvesting rainwater plays a central role in the ecological stability of any landscape. This cools the environment, infiltrates into soil and sustains natural groundwater levels. If this water drains off, the risk of flooding and inundation increases and without infiltration affects severely the housing environment. There are number of possibilities to catch rainfall water and reuse it within a cluster. One option available is through green roofs which partly retain water and slow down the run-off. Water from roofs and terraces gets collected in reservoirs or rainwater harvesting tanks. Pavements can be made into open-grid green pavements and fixed surfaces can be built in such a way so as to allow water to flow to green areas. Such multiple clusters will help develop an overall strategic approach to achieve sustainable urban water management in the settlements of future.

D. City-level Cluster Planning

Present-day development policies at city-level are looking at 'Re-densification' as a tool to control urban sprawl and thus reducing the load of increasing urban population.

By raising the building heights within the city - number of floors - the city planners allow more population to be added to the existing city fabric. However this measure does not resolve the prevailing space problems faced by the city dwellers. Re-densification without providing the basic requirements of citizens, in areas which already lack social infrastructure, market places, green areas, will introduce new problems in addition to the existing ones. So it should be agreed that re-densification should not just be represented a vision characterized by soul-less concrete skyscrapers and buildings connected to one another by a network of ducts, a concretized landscape devoid of any green, repetition and conformity and no diversity. Instead re-densification should reflect modern development through 'Clusterization', with high rise towers along with innovative cluster development models of sustainable water management, sustainable mobility management, sustainable energy management and lush landscape. Such a development would help to improve and consolidate existing urban areas.

E. Transportation

Energy consumption of the transport sector is very high, which means that it is also a big producer of greenhouse gas emissions.

For the clusterization concept to be effectively worked out, in Indian context, for the mobility management, it will need the future proposal to incorporate work places, social infrastructure and residential areas to be planned together as sustainable clusters along with the re-densification of these areas within the city. This can also help in fusion of last mile connectivity in our plans by encouraging use of more non-motorized green mode of transport, fast public transit means and reduction in private individual mode of transportation, thereby helping to reduce more of GHGs.

Having such polycentric development – i.e. multiple clusters - will help in shifting towards a green and healthy living in the cities of India. Already majority Indian cities are developing organically with multiple nodes within the city. It is these nodes that can be targeted and planned for in such a way that multiple sustainable clusters can be formed and all these clusters functioning in synchronization.

V. CONCLUSION

A country could ensure balanced and sustainable development by developing different clusters located all over the states. Smaller investment could be sufficient for establishing a cluster where all backward as well as forward linkages are available. According to our analysis, along with individual cluster development, a coordination mechanism would be very useful which give directions and support to the cluster development projects. 'Clusterization', as discussed above, may be top-down or bottom-up approach depending on the development policy implementation and funding agency. Therefore to conclude, cluster development could be a powerful tool for sustainable growth of a country and a fast developing country like India can go for 'Clusterization' based development approach, by ingraining the spirit of this concept into India's development policies and development planning efforts.

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