Brief for GSDR 2015

Decoupling Growth from Resource Generation

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A. Introduction

Global economic and social development over the last two centuries has been largely achieved through intensive, inefficient and unsustainable use of the earth's finite resources. Over the course of the 20th century global resource extraction and use increased by around a factor of 8[9]. Global population grew around half as fast and GDP grew at a significantly higher rate (by a factor of 23). Given a world population that grows by 200,000 people each day and especially a rapidly growing global "middle class" associated with resource-intensive consumption patterns, the demand for natural resources will continue to increase. According to the Global Footprint Network, if current economic and production trends persist, we will need the equivalent of two Earths to support us by 2030[1].

The global challenge today is to lift one billion people out of absolute poverty and to set the pathway for meeting the needs of nine billion people in 2050 while keeping climate change, biodiversity loss and health threats within acceptable limits ("planetary boundaries"). For present and future well-being, there is a need to achieve sustainable resource management by decoupling natural resource use and environmental impacts from human well-being.

*The views and opinions expressed are the author's and do not represent those of the Secretariat of the United Nations. Online publication or dissemination does not imply endorsement by the United Nations. Authors' can be reached at abhamra@devalt.org.

[1] Global Footprint Network, 2012

B. Decoupling: Challenges

i. The Dichotomy of Economies

The developed economy, typically represent the *'consumption society'*, is exploiting a large share of the global natural resource base. These affluent unsustainable lifestyles are based on and are intricately interwoven with the consumption and production patterns of the current economic development model of the West[2].

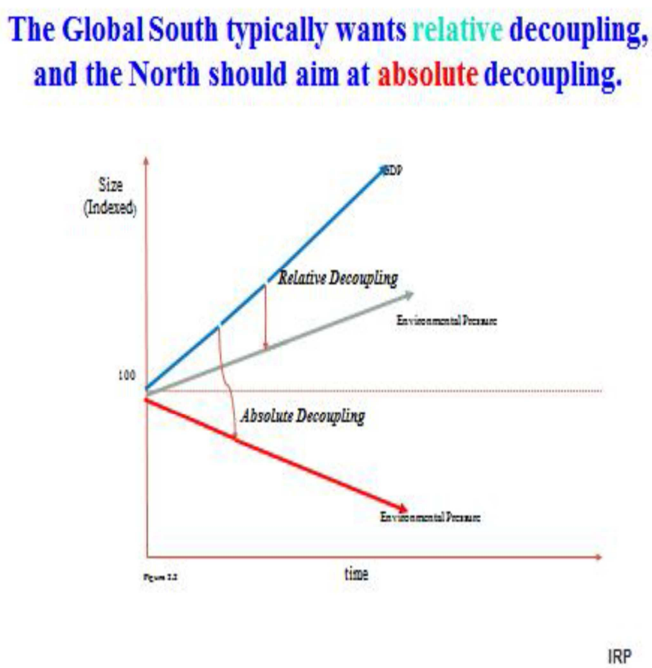
On the other hand, developing economies, with large numbers of poor living in substandard conditions, are both agents and victims of environmental degradation. They represent the '*subsistence society'* with high 'direct dependence' on natural resources for livelihoods and basic needs. A reduction in stocks of natural capital and flows of ecosystem services disproportionately harms the wellbeing of the poor and the resilience of their communities. In their quest for food security and basic need provision, the poor overuse limited resources available to them resulting in environmental degradation further reinforcing this 'downward spiral' or 'vicious circle'[3].

ii. 'Common but Differentiated Challenges of Decoupling'

It is clear that a global transition in natural resource consumption will need an **absolute decoupling** in developed *(*industrialized) countries (i.e., reduction of aggregate resource consumption) together with a **relative decoupling** in developing countries (i.e., reduction of growth *rates* of resource consumption) until such time as the developing countries attain acceptable standards of living, after which they, too,

[2] Mont 2007
[3] IFAD 2011

will have to adopt measures to achieve absolute decoupling. These common, but differentiated opportunities and challenges of decoupling in developed and developing countries can be made clearer by referring to Paul Ehrlich´s identity[39]. (See Appendix 1)



iii. A 'Knife-Edge'- Problem of Absolute Decoupling

In most countries of the North the acceptance of a strategy on absolute decoupling of GDP from the use of nature will be low if it is not connected with at least stabilizing or increasing employment. It can be demonstrated by a formal comparison of growth rates again that this condition – cet.par. – can be perceived as a societal '*knife edge'*- problem.

Using the following definitions,

- Labour productivity (LP) = Gross Domestic Product (GDP) / Jobs (J)
- Resource productivity (RP) = Gross Domestic Product (GDP) / Total Material Requirement(TMR)
- Energy productivity (EP) = Gross Domestic Product (GDP) / Energy (E)

a necessary condition for sustainable development - more jobs, less use of nature - can be demonstrated by the following:

Only if the growth rate of GDP > growth rate of LP ･ Employment increases
On the other hand:
Only if growth rate of GDP < growth rate of RP (or EP)

･ Resource use (or energy) decreases

Thus to meet the necessary condition of sustainable development the following formal inequation must hold:
Growth rate of LP <Growth rate of GDP < Growth rate of RP (example for annual rates: 1.5% < 2% < 2.5%)
Thus, focussing economic policies only on maximising *'economic growth'* without fostering resource productivity will not end up at absolute decoupling. On the other hand, the growth rate of GDP must be high enough if additional jobs were to be created with an average growth of labour productivity. The formal inequations hold under cet.par. conditions. To alleviate this *'knife edge'* problem other strategic options like e.g. the reduction of average labour time, structural changes to a service/recycling economy, new models of wealth, lifestyle changes and sufficiency policies have to be taken into account.

iv. The Decoupling Triangle

Supporting micro-level activities that are compatible with long-term goals and conditions will require a systemic perspective and a way to link the micro level of where change happens to the macro level of where impacts are measured, policies are made and targets are set. It also requires knowledge on how to cushion '*rebound effects*[4]*'* over time. For example, even though the technical feasibility of an **absolute** decoupling and a tremendous increase of resource productivity were demonstrated by scenarios and might be the aim of national resource policies, counteracting social and economic reactions can '*eat up* even massive increases in product, process or sector specific resource productivities.

[4] See for example Madlener and Alcott (2011). Here the term „rebound effect" is used in a general and pragmatic way to include e.g. direct/indirect rebound effects as well as growth, structural and quantity effects.

It is the triangle of **efficiency** ("more with less"), **sufficiency** ("less can be more") and **consistency** ("better than more") on which policies and measures for decoupling should be based.

At the end of the day, what counts from an ecological and ethical perspective is to **sustain ecosystem services for all peoples and generations to come**43.

v. Equity and Decoupling

There is a global consensus on using decoupling as one of the strategic approaches towards a more green and sustainable economy. Inequity matters for both instrumental as well normative reasons such as fairness and meritocracy[5]. The three principles of equity, in order of priority, are[6]:

- Equal life chances: The circumstances and conditions of an individual (those not under his/her control like gender, ethnicity and fathers/mothers job etc) should not have an effect on the outcome (such as health, educational attainment and availability of opportunities etc).
- Equal concern for people's needs: Basic necessities (such as food, shelter, water and sanitation etc) distributed according to the level of need.
- Meritocracy: Rewards and benefits are distributed as per an individual's ability based on the notion of fair competition.

We need to look beyond the current focus on (a) protection and compensation (b) attaining co-benefits and helping in adaptations and include (c) anchoring the structural transformations needed by looking at rights and regulations etc48.

C. Essential Adjuncts as a Core Strategy in Decoupling

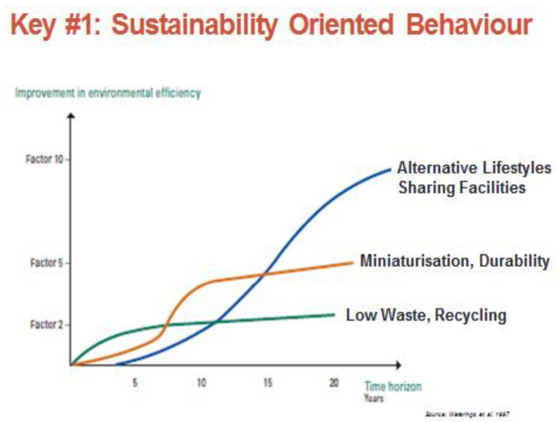
Decoupling will require changes across strategic adjuncts like knowledge, capacity, policy, technology and finance. It will require structural changes in business models, lifestyles and modes of governance and will primarily rely on a combination of changes gained through new alliances of fast-movers working together to demonstrate desirable alternatives to business-as-usual[7].

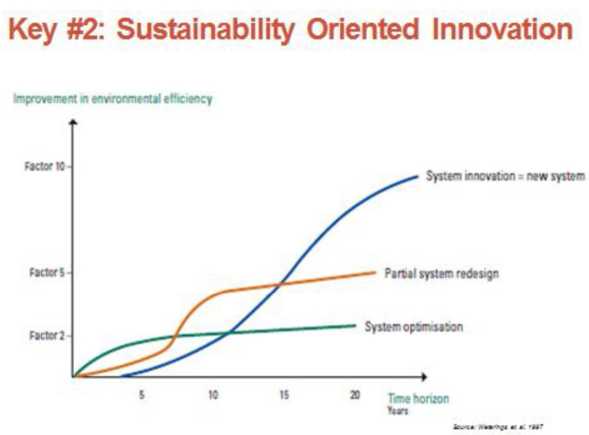
i. **New types of knowledge** are needed to understand, foster, manage and improve this transition. Targets for decoupling resource use based on scientific knowledge in the light of risk and uncertainty are necessary. Participatory processes are essential in the production and usage of scientific knowledge.

ii. **Capacity** in skills and innovation are required in both developed and developing countries. Investment in awareness raising and skills development is an important precondition for promoting resource efficiency in companies. To this end, the structure of universities with rigid disciplinary orientation and institutional inertia needs to be revisited to equip the next generation of scholars, entrepreneurs and employees to handle challenges of the future.

iii. **Policy** needs to play a dual role for promoting decoupling. Policies need to build the framework and set an overall direction for change. This includes stating clear and binding targets for resource use and emissions (related to planetary boundaries) and creating a level playing field for eco-innovators by recognising both economic and environmental costs and benefits of their activities. Secondly, policies provide support for eco-innovation through science, innovation and enterprise, as well as through green public procurement and public-private partnerships.

[5] Cobham and Sumner, 2013
[6] Jones, H., 2009
[7] EIO 2013





iv. **Technologies** are expected to play a role in the shift to a resource efficient economy and the corresponding restructuring of industrial processes needed to modernise industry and foster competitiveness. Key enabling technologies exist in the areas of biotechnology, advanced materials, nanotechnology, photonics and micro and nano-electronics.

v. The pursuit of resource efficiency not only leads to high-tech but also to low-tech and affordable solutions for customers in emerging markets. More creative ways of approaching functionality, changed consumption behaviours and social innovation are essential to any systemic change. These '***frugal innovations***' aim to bring products back to a level of basic simplicity and are designed to be inexpensive, robust and easy to use.

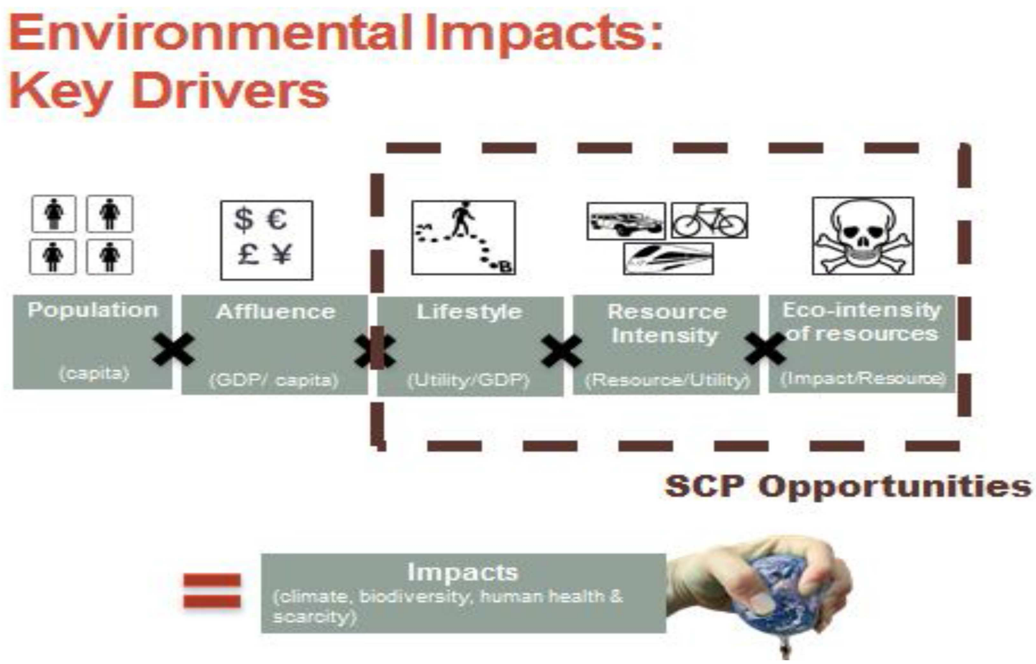
vi. **Finance** and finance structures are key to providing the means for investing in a sustainable transition. New approaches urgently need to bring together technical and financial experts in order to develop and implement business models and innovative financing schemes. A key question for further research is how to finance innovations with long-term paybacks, when profits for the company are needed over the short term.

vii. **Structural and behavioural changes** in how business and governments are run especially in *rich countries* are key to meeting future demands with limited resources. Integrating environmental sustainability in value creation and distribution of current businesses rather than as an externality is required. Similarly, changes in the organisation of government may be necessary along with strong leadership and overarching targets. Lifestyle changes particularly in rich countries are needed to create demand for new and green innovations to pave way for the political willpower needed to instigate structural change.

viii. A variety of studies have identified the transformation of today´s linear 'take-make-dispose' patterns towards a **circular economy** as one of the most promising strategies for a successful decoupling of resource consumption and economic growth[57]. From a resource point of view the optimal approach is to prevent waste generation in the first place. The circular economy approach not only significantly decreases demand for natural resources, but also offers massive opportunities for new green business models.

Appendixes

Appendix 1- Paul Ehrlich´s identity



The formula[40] I = P x A x T (I=Environmental Impact; P=Population; A=Affluence per capita; T= Technology) can be interpreted as follows: Taking resource use (R)[41]an the indicator for I, Y/P (per capita income) as the indicator for *'affluence '*and T as the indicator for resource intensity (reciprocal of resource productivity) then the relation R = P x Y/P x R/Y (reformulated in growth rates (w_R = w_P + $w_{Y/P}$ + $w_{R/Y}$))leads to a simple conclusion: With a positive growth rate of population (w_P) and for per capita affluence ($w_{Y/P}$) the global environmental impact can only be constant (w_R = 0) if the resource intensity decreases by the added growth rates (w_P)+ ($w_{Y/P}$).

The strategic message on a global scale is quite clear: The resource shortages and environmental impacts of resource use can become significant constraints on human progress unless we urgently find ways to reduce the growth of population (P), accept lower standards of living (Y) and/or significantly raise resource productivity.

But this global perspective has to be differentiated at least according to development stages: Concerning the global environmental impact (I) differentiated for developed and developing economies.

- I_{IC} can be **absolutely** reduced in **developed countries** (IC; assuming constant population) if the growth rate of resource productivity is higher than the increase rate of per capita affluence
- I_{DC} can be **relatively** reduced in **developing countries** (DC; assuming growing population and high GDP-growth) if the growth rate of resource productivity is as high as possible to offset the necessary increase of per capita affluence.

Appendix 2- Good Practice Case Studies from India

There has been sporadic evidence of decoupling in the Indian context. The following three case studies highlight the approach followed and how they contribute to the core principles of decoupling.

EFFICIENT WATER UTILISATION THROUGH PARTICIPATORY GOVERNANCE

Developing economies are particularly sensitive to surface water impacts of climate change and subsequent overuse of ground water because their economies and society are heavily dependent on agriculture. For e.g. ground water overdraft rate in northwest India is 56%[8]. Hiware Bazar in Maharashtra is a semi-arid village that from 1970s to 1990s ran out of most of its natural assets. The village faced an acute water crisis as a result of which during 1989-90, only 12% of the land was cultivated resulting in rampant poverty in the region. Like many other places in India, Hiware Bazar was in a classic overshoot and decline mode with the potential risk only becoming clear when wells ran dry. Water retention is limited due to poor permeability of the geological structures, and accentuated by degradation of forests and green cover over the years. The available water is poorly managed and access to water is determined by land and the capital to dig deeper and deeper wells. As a result large parts of the region are categorized as over-exploited, critical or semi-critical in terms of groundwater availability. Acute water shortages due to vegetation loss were undermining agricultural productivity.

Indicators	1991	2011
No of families	180	236
No of poor families	168	3
No. Landless Families	22	6
Annual Per Capita Income (INR)	832	30,000
Literacy (%)	30	95
Groundwater Availability (feet)	19-120	15-40
Area under irrigation (ha)	125	650
Area under summer irrigation (ha)	1-2	80
Cropping Intensity (%)	94	164
Fodder Availability (tonnes)	1500	6000

Source: Quarterly research Note, IDFC , June 2012

The village community however managed to turn the face of the village around in a matter of 5 years from 1995-2000. Agricultural production potential has increased by several orders of magnitude and contributed to reducing poverty by 73% in less than a decade[9]. An average villager earns almost double of most of India's rural population, with an average income increase of 20 times over creating 54 millionaires (Hiware Bazaar e-panchayat). Unlike other villages that desperately wait for government supplied tanker water to meet their drinking needs, Hiware Bazar today has assured drinking water. The number of wells has increased from 97 to 217. Land under irrigation has increased from 120 Ha in 1999 to 260 Ha in 2006 (Hiware Bazaar e- Panchayat). They have also managed to plant a rabi crop, albeit over reduced acreage. Watershed development and strict observance of rules that preserve the water table have been central to this village's remarkable economic transformation[10].

A fundamental premise of the program was the adoption of participatory planning processes. It encouraged villagers to treat as a community resource, and empowered them to prioritize uses of available water. To institutionalise sharing of water, the village introduced a practice of water budgeting. Using 'water bank' principle, the budget ensures that the village does not draw more water than it stores in a year, and a small amount is kept in reserve. Depending on rainfall in that year, available water is allocated amongst various uses, with first priority for drinking water for humans at 50 litres per capita per day (lpcd)[11]. Of the remaining water, 70% is reserved for irrigation and 30% is stored for future use by allowing it to percolate and recharge groundwater[12].

The irrigation was mainly carried out through energy and water efficient technologies of drip irrigation, open irrigation and with minimum use of ground water. Bhattarai et al.(2008) estimated that water efficient irrigation investment projects in India found economic multipliers of as much as three times. Such initiatives that deliver associated multiplier effects are a key part of the decoupling process.

Furthermore the village specially targeted ecological regeneration and also took advantage of the existing Employment Guarantee Scheme to regenerate

[8] Briscoe 2008

[9] TEEB 2012

[10] IDFC 2012

[11] ibid

[12] The Nature of Cities 2013

degraded village forests and catchments and to restore watershed ecosystem. The villagers resorted to various watershed conservation techniques like contour trenching and bunding, tree plantation, rainwater harvesting, recharge of ground waters. The subsequent regeneration of degraded forests and building of earth embankments around hills have also helped to conserve rainwater and recharge groundwater.

Hiware Bazar imposed grazing restrictions on limited areas at a time viz. on a rotational basis, during reforestation. Bans were implemented in a staggered manner. For instance, a sudden and complete ban on open grazing would have an adverse impact on landless that rely on common pastures. After reforestation was complete, households could collect one head load of grass a day from common lands (cut by sickle to preserve the roots) for Rs. 100 per year[13]. This fee is waived for poor/landless families. Similarly, the tree-cutting ban was imposed incrementally beginning with forest land then moving to other areas. Babul trees were initially exempt to provide a source of firewood.

The success of Hiware Bazar rests on changing mindsets and participatory governance. It allowed the villagers to debate and prioritize their development goals, and manage their common resources such as water in an equitable and sustainable manner. Replication efforts for such large scale programs need convergence of development objectives, public and private funds and ardent involvement of multiple actors like government, beneficiaries and NGOs (as technical support). The keystone however is strong local leadership that creates the community drive and motivation.

CONSTRUCTING CHANGE WITH GREEN BUILDINGS

The scale of urban expansion in India is and will continue to be enormous, driven by economic and population growth. In 2011–2012, India's construction sector accounted for 8.2% of the country's GDP, employing 41 million people, and is poised to become the world's third-largest construction sector by 2018. Over the next ten years, the sector is expected to grow by 16-17%.The construction and use of buildings, driven by rapid urban expansion, is likely to impose tremendous pressures on the natural environment.

The construction sector has a large and growing resource footprint. It accounts for 30% of electricity consumption in India, growing at 8% a year and 23.6% of the national greenhouse gas (GHG) emissions[14]. Materials and equipment generally account for nearly two-thirds of total construction costs. Cement production is expected to increase from 228.3 Mt in 2010–2011 to 600 Mt by 2020. Despite a fall in the emission intensity of the cement industry, in 2007 it generated 129.9 Mt CO2. Some 200 billion bricks are produced each year, generating emissions of 41.6 Mt CO2. It is estimated that 45% of India's steel output, 85% of paint, and 65%–70% of glass are used in the construction industry. The increased demand for materials and the consequent pressures on natural resources result in increasing material scarcity and escalating costs of construction.

According to the Bureau of Energy Efficiency, two-thirds of India's building stock that will be required by 2030 has yet to be built. Today's infrastructure investments will play a critical role in determining future resource intensity and affect India's ability to decouple resource consumption from economic growth.

Urbanisation in India is less advanced than in many other countries, which presents an opportunity to avoid being locked into energy- and resource-intensive infrastructure. There is considerable potential for the further promotion of green buildings to reduce the environmental impact of construction and urbanisation in India.

The footprint of buildings certified by the Indian Green Building Council (IGBC) is currently over 1130 million m2. The market for green buildings in India is projected to grow three-fold between 2011 and 2014, reaching $30 billion. With proven and commercially available technologies, energy consumption in new and existing buildings can be cut by an estimated 30% to 80%, with potential net profit during the building's lifespan[15]. Buildings compliant with India's Energy Conservation Building Code (ECBC) are estimated to be 20% to 30% more efficient than conventional

[13] IDFC 2012

[14] Parikh et al. 2009

[15] UNEP SBCI 2007

buildings (Parikh, 2011). Besides energy efficiency, using recycled building materials saves between 12% and 40% of the total energy used during materials production, depending on the material[16]. Building design can maximise natural lighting and ventilation, which reduces energy needs and improves the quality of indoor air. These measures have a noticeable impact on the operating costs and result in savings over the building's lifetime.

The Development Alternatives Head Quarters in New Delhi is an example of how construction can be decoupled from resource use, such as energy, through material efficiency. Aiming at zero emissions, it is described as a living ecosystem: a fine balance between both natural and man-made processes using environment-friendly energy, resource and energy efficient building materials and water management methods for conservation of water. Its construction has involved a wide range of resource-saving strategies, ranging from the use of eco-materials and natural lighting to rainwater harvesting and water and material recycling. A key factor of success was the People Driven Design approach, wherein the design evolved over an interactive process between the DA staff and the architects and is sensitive to requirement of universal access. The building reaffirms a commitment to People and Nature. It uses 30% less embodied energy through the highly efficient use of low energy natural materials based building elements like mud and fly ash blocks instead of burnt brick or concrete timber for doors and windows. 90% materials sourced from around Delhi; thus involving minimum transportation. The stone flooring pattern designed to reduce waste to less than 5%. 30% less steel and cement is used owing to the use of innovative technologies like Ferro-cement channels with minimal steel bars and chicken-wire mesh, Shallow domes with Fly Ash blocks requiring no steel reinforcement and Short-span reinforced cement concrete frame for basic structure

40% less operational energy is consumed via user acceptance of indoor temperature range from 180 to 280 Celsius. The orientation is optimised to maximise natural lighting and ventilation and minimise heat gain. "Green clothing" (planting on building façade), cavity walling and built-in shading devices minimise heat gain. An innovative "Hybrid" air conditioning system minimises use of energy and water prioritising evaporative cooling for hot and dry months and is supplemented by (CFC free) refrigerant cooling for hot and humid months.

The use of low-cost, local and low-embodied energy materials remains important for sustainable construction, and can support local economic development while also reducing environmental impacts[17]. In order to replicate and scale up such initiatives it is important to create an ecosystem where eco-friendly materials, technology and expertise are available and accessible to all.

ENERGY EFFICIENT TRANSPORTATION

Delhi ranked 3rd in a World Health Organization (WHO) survey of the most polluted cities in the country. Besides meteorological conditions contributing to the presence of natural dust, the transport sector is one of the major contributors towards the rising ambient air pollution levels and greenhouse gas emissions (13% of national emissions). Over the last three decades, Delhi has seen an unprecedented growth in the number of personalised vehicles. Delhi has more vehicles than Mumbai, Chennai and Kolkata with more than 90% of the vehicles being personal. The total number of vehicles registered in Delhi in 2011 is equal to the combined registrations done in Mumbai, Hyderabad and Chennai[18]. Arecent trend observed, is that of the increasing consumption of both major auto fuels i.e. petrol and diesel. The contribution from the vehicular sector increased from 23% in the year 1970/71 to as much as 72% by the year 2001[19].

The government has undertaken many initiatives to introduce energy efficient transportation measures in the city. The main source of vehicular pollution is the fuel itself. Initially, policies were introduced by national and state governments based on vehicle and fuel efficiency, such as phasing out older vehicles and making compressed natural gas (CNG) a mandatory fuel in public transportation. In order to counter the

[16] ibid

[17] UN Habitat 2011

[18] Times of India 2012; http://articles.timesofindia.indiatimes.com/2012-11-26/india/35366083_1_vehicles-chennai-metro-bangalore

[19] DPCC n.d.

increasing air pollution load and carbon emissions in Delhi, the Supreme Court passed the orders to move all the public transport on CNG by March 31, 2001. CNG (117 pounds of CO2 emitted per million Btu of energy) is less carbon intensive than petrol/ diesel based fuels (157 / 161 pounds of CO2 emitted per million Btu of energy), leading to fewer emissions for the same amount of fuel spent.

Some fiscal measures were put in operation for making conversion to CNG a financially feasible option for all stakeholders. Following the Court's order of April 5, 2005, for the first time in the country, penalty was imposed on the basis of polluter pays principle, on diesel buses for violating the Court order and not moving to CNG. This penalty has generated a huge corpus of Rs 30 crore that is today available to the Delhi government to fund other emissions control measures in the city[20]. Incentives like Sales-Tax exemption and interest subsidy on loans to the auto rickshaw owners also helped. This experiment demonstrates how it is possible to develop fiscal instruments for improvement of transport and technology to control emissions. This has been a pioneering effort and should build on to develop future fiscal policies in the city.

The co-ordinated measures for affecting the switchover were put in place by the Government of Delhi through multipronged action as different agencies were responsible for ensuring the environment friendliness of public transportation. The Government of Delhi explored all possibilities for using CNG, by holding discussions with vehicle manufacturers and other public transport agencies. Vehicle manufacturers were asked to bring CNG technology into the country. The Gas Authority of India Ltd. was requested to lay underground pipelines for setting up of new CNG stations. A phase out plan was put into place to ease the switchover.

A CPCB study shows that there has been a significant reduction in pollution at traffic intersections and in industrial areas in terms of CO, NO2, lead, SO2, and suspended particulate matter[21]. While there were around 1000 CNG vehicles in April 1998, by 2003, there were 70,249 vehicles including taxis, auto rickshaws and 9000 buses plying exclusively on CNG. CNG is also the cheapest of auto-fuels, as per the prevailing prices in May 2003, CNG compares favourably with diesel and petrol. However, use of clean fuels by the public transport system is only a part of the solution.

More recently, policies are focused on improving public transportation infrastructure, with the city's new metro as the flagship project. The first two phases were completed on 2006 and 2011 respectively, with Phase III and IV to be completed by 2021. Approximately, for 15 lakh passengers travelling in the Metro, 1.5 lakh vehicles are off the road[22]. It has also used flyash bricks in construction activity which, the corporation says, will save 3.9 million tonnes of carbon dioxide in 10 years (ibid).

It is the first metro rail and rail based system in the world that received carbon credits under the United Nations Framework Climate Change Convention Clean Development Mechanism. Under the regenerative braking process, whenever trains on the Metro network apply brakes, three phase-traction motors installed on these trains act as generators to produce electrical energy which goes back into the over head electricity (OHE) lines. The regenerated electrical energy supplied back to the OHE is used by other accelerating trains on the same service line, thus saving overall energy in the system as about 30% of electricity requirement is reduced[23]. It led to a prevention of nearly 90,000 tonnes of CO2 from 2004 to 2007 with an additional 39,000 tonnes saved in 2008 (ibid). Every passenger who chooses to use Metro instead of car/bus contributes in reduction in emissions to the extent of approximately 100 gm of carbon dioxide for every trip of 10 km and therefore, becomes party to the reduction in global warming (ibid). Over a two year period from 2008 to 2009, the Delhi Metro Rail Corporation earned nearly 4.8 crores INR through the sale of 1,64,000 certified emission

[20] CPCB 2003

[21] The Hindu--Delhi, "Marked Drop in Pollution Levels," 02/14/00

[22] Times of India 2011, http://articles.timesofindia.indiatimes.com/2011-01-19/delhi/28363503_1_carbon-credits-carbon-trading-metrotrains

[23] Dehli Metro Rail Corporation (DMRC n.d.)

reductions (CERs)[24]. The money earned through the sale of CERs is being used for stimulate research and development activities and to give training to train operators for optimum regeneration. Innovative technology has helped reduce energy and electricity consumption, thereby decoupling the public transport system from excessive resource use.

This success is now being replicated in other cities in India, extending to other modes of transportation. For e.g. Ahmedabad introduced the country's first Bus Rapid Transit System. More than 60,000 people switched from motorized two- and three- wheelers reducing 288,000 metric tons of CO2 per year. Providing better and higher quality service is also preventing passengers from switching from buses to private cars and motorcycles even while their income rises.

References:

Bhattarai, Barker, and Narayanamoorthy (2003). Who benefits from irrigation investments in India? Implication of multipler estimates for cost recovery and irrigation financing.

Bringezu, S. (2009). Visions of a sustainable resource use. In: Bringezu, S. and R. Bleischwitz (eds). Sustainable Resource Management: Global Trends, Visions and Policies. Greenleaf Publisher: 155-215.

Briscoe, J.(2008). India's Water Economy : Bracing for a Turbulent Future, World Bank

DPCC (n.d.). Towards Cleaner Air: A case study of Delhi.

EIO (2013). Europe in transition: Paving the way to the green economy through eco-innovation. O'Brien, M. and M. Miedzinski (eds.). Eco-Innovation Observatory. Funded by the European Commission, DG Environment, Brussels.

IDFC Foundation (2012). Hiware Bazar: A water-led transformation of a village, Quarterly Research Note.

International Fund for Agriculture Development-IFAD (2011) Combating Environmental Degradation. Conference on Hunger and Poverty : A Popular Coalition for Action

IFEU et al. (2013), India´s Future Needs for Resources. Dimensions, Challenges and Possible Solution, on behalf of GIZ, Heidelberg August 2013, forthcoming

IGEP- Indo German Environment Partnership (2013): India's Future Needs for Resources Dimensions, Challenges and Possible Solutions

Kothari, A and Shrivastava A.(2012) Churning the Earth : The Making of Global India

Madlener, R. and Alcott, B. (2011). Herausforderungen für eine technische-ökonomische Entkoppelung von Naturverbrauch und Wirtschaftswachstum: unter besonderer Berücksichtigung der Systematisierung von Rebound-Effekten und Problemverschiebungen (Challenges of a technological and economic decoupling of natural resource use and economic growth: in particular considering system effects of the rebound effect and problem shifting). Enquete Commission for Growth, Well-being and Quality of Life of the German Parliament.

Mont, O. (2007): Concept paper for the International Task Force on Sustainable Lifestyles. Third International Expert Meeting on Sustainable Consumption and Production, Stockholm, 26-29 June.

Parikh et al. (2009).CO2 emissions structure of Indian economy

TEEB (2010): The Economics of Ecosystems and Biodiversity: TEEBcase by S. Singh. Enhancing agriculture by ecosystem management in Hiware Bazaar, India

The Nature of Cities (2013). Urban Ecological Footprint and a Livable Future

UN Habitat (2011).Global Report on Human Settlements

UNEP (2011) Decoupling natural resource use and environmental impacts from economic growth, A Report of the Working Group on Decoupling to the International Resource Panel. Fischer- Kowalski, M., Swilling, M., von Weizsäcker, E.U., Ren, Y., Moriguchi, Y., Crane, W., Krausmann, F., Eisenmenger, N., Giljum, S., Hennicke, P., Romero Lankao, P., SiribanManalang, A., Sewerin, S.

UNEP (2013). Metal Recycling: Opportunities, Limits, Infrastructure, A Report of the Working Group on the Global Metal Flows to the International Resource Panel. Reuter, M. A.; Hudson, C.; van Schaik, A.; Heiskanen, K.; Meskers, C.; Hagelüken, C.

[24] Times of India 2011; http://articles.timesofindia.indiatimes.com/2011-04-13/delhi/29413468_1_carbon-credits-dmrc-delhi-metro-trains

UNEP (2014) Assessing Global Land Use: Balancing Consumption with Sustainable Supply. A Report of the Working Group on Land and Soils of the International Resource Panel. Bringezu S., Schütz H., Pengue W., O ́Brien M., Garcia F., Sims R., Howarth R., Kauppi L., Swilling M., and Herrick J.

UNEP SBCI (2007).Buildings and Climate Change Summary for Decision-Makers