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Rural-Urban Connectivity in Achieving Sustainable Regional Development

(Background Paper for EST Plenary Session-3)

Final Draft

This background paper has been prepared by Lauren Joy Avery, Madan B. Regmi, Ganesh Raj Joshi and Choudhury Rudra Charan Mohanty for the Tenth Regional EST Forum in Asia. The views expressed herein are those of the author only and do not necessarily reflect the views of the United Nations.

Rural-Urban Connectivity in Achieving Sustainable Regional Development

Background paper for the Intergovernmental Tenth Regional Environmentally Sustainable Transport (EST) Forum in Asia

For the plenary Session 3: Rural-Urban Connectivity in Achieving Sustainable Regional Development

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Final

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1. Introduction

Connectivity refers to the capacity for areas and people to be connected, either physically or non-physically, through transport or communication. Connectivity has been recognized as an important factor in sustainable development with several institutions and organizations undertaking studies to examine the effects of different connectivity modes on regional development, such as information and communications (ICT) connectivity, trade and transport connectivity, and people-to-people connectivity[1].

Connectivity in the aforementioned sub-categories has become a key topic in recent discussions and initiatives related to regional development, including in the Asia Pacific region. The Theme Study for the ESCAP Annual Commission Session in 2014 was on Regional Connectivity for Shared Prosperity that looked at trade, transport ICT and energy connectivity and their role in poverty reduction and equal development. The Transport and Communications Bulletin for Asia and the Pacific, No. 86 emphasizes sustainable rural access and the development of the relevant infrastructure in the region[2]. The significance of connectivity to landlocked regions was recognized at the Second United Nations Conference on Landlocked Developing Countries and issues will be accordingly addressed through the Vienna Programme of Action for the Landlocked Developing Countries for the Decade 2014-2024[3]. Similarly, Article 50 the New Urban Agenda, adopted in 2016 as an outcome of the Habitat III Conference refers to the importance of increasing urban-rural connectivity through sustainable transport and infrastructure in order to promote productivity and draws attention to the co-dependency of rural and urban areas in achieving this goal[4].

The aim of this paper is to examine rural-urban transport connectivity, which is defined as a measure of accessibility without regards to distance, taking into account the relative travel time between two nodes (locations) which facilitates the movement of people and goods. However, ease and cost[5] can also be considered a factor of connectivity, all of which can be affected by the quality of the connections, e.g. paved or unpaved roads[6]. The level of connectivity depends on the number of connections between nodes, which can have a considerable impact on the economic development of a region[7], and achieving the Sustainable Development Goals (SDGs). The number of connections between nodes, in turn, relies on the geographic location of each node. Nodes at central locations have, by default, more connections to outlying nodes and therefore have higher connectivity. This explains development patterns of urban centres, which have more connections to outlying areas, as opposed to rural areas, which, because of their geographic characteristics have fewer connections, or in some cases none at all resulting in isolation. The key to rural-urban transport connectivity is linkages between rural and urban destinations.

The paper will go on to outline rural-urban connectivity status in Asia and the Pacific in section 2, followed by the benefits of connectivity and methods of measurement. In section 3 approaches to sustainable development and connectivity will be discussed, and section 4 identifies transport modes for urban-rural connectivity. Finally, conclusions and recommendations are suggested in section 5.

[1] ESCAP, 2014
[2] ESCAP, 2016
[3] United Nations, 2014
[4] UN-Habitat, 2016
[5] Alstadt et al., 2012
[6] Perz et al., 2014
[7] Woollett, N., Knight, P., & Redfern, R., 2009

2. Rural-urban Connectivity Status in Asia Pacific

As a largely agricultural region 87 per cent of the world's small farms are located in the rural areas of the Asia Pacific and regional agriculture provides livelihoods for 2.2 billion people[8]. In parallel, the region has seen rapid urbanization over the past few decades and is now home to more than half of the world's mega-cities. Whilst urbanization and industrialization in the region has pushed economic growth and increased GDP exponentially in comparison to the rest of the world, evidence suggests that this growth is not equal across all sectors. For the Asia pacific region the gap between agricultural productivity and the rest of the economy is widening- adding to the increasing inequality in the region[9]and in particular between rural and urban areas. This highlights the reality that rural areas are increasingly being left behind in the economic development of the region. It has been consistently shown that the effects of lack of connectivity can have a profound effect on the development of rural areas, a country and the region as a whole, disproportionately affecting Least Developed Countries (LDCs), Land Locked Developing Countries (LLDCs) and Small Island Developing States (SIDS). In order to help achieve the Sustainable Development Goals by 2030 there should be more emphasis on rural-urban connectivity and its role in closing the rural-urban development gap.

2.1. Benefits of rural-urban connectivity

Rural-urban connectivity is multi-beneficial. Particularly for the Asia Pacific region that contains 10 of the world's 32 landlocked countries, as well as enabling better access to services located in urban areas such as healthcare, education, and for increased political and social participation, connectivity to urban markets allows lengthening of market chains and connecting rural producers to the wider market, enabling participation in the national and regional economy.

It is estimated that 40 per cent of the Asia Pacific region's rural population, or 700 million people, do not have access to an all-weather road[10]. When rural areas are isolated from other rural, urban and peri-urban zones they are more likely to be trapped in poverty due to decreased access to healthcare and educational provision and participation in social and political activities and affecting a higher proportion of disadvantaged groups, particularly women, the elderly and the disabled. Perz et al (2014) suggest that increasing the connectivity between rural and urban areas through transport infrastructure can help to mitigate the effects of isolation and provide interaction connectivity; that is the ties between rural and urban centres including social and economic interaction. Their research in the Southwestern Amazon found that rural households with better access connectivity to urban centres have more commercial ties and more diverse livelihoods than rural households with poorer access. Similarly, the Rural Infrastructure Program II Bangladesh showed an increase of 197 per cent in household income in addition to reduction in travel costs and increases in secondary school and healthcare service attendance[11]. These studies highlight the role of road connectivity in stimulating local economic growth by lengthening market chains and reducing transport costs.

Building better transport infrastructure and greater rural-urban connectivity is important to improve the efficiency and volume of economic activity in rural areas. This benefit relates directly to SDG Goal 8, which calls for sustained, inclusive and sustainable economic growth through employment and access to work. Road networks that enable faster and safer access to markets, jobs and other economic and social activities provide significant socio-economic benefits to rural communities. It further helps with income generation and

[8] IFAD, 2016
[9] IFAD, 2016
[10] ESCAP 2015
[11] Sieber & Allen, 2016

improvement of farmer's livelihood activities. Many studies conducted in People's Republic of China (hereafter China), India, Lao PDR, and Nepal show that improved rural-urban transport connectivity is a necessary condition for economic development and poverty alleviation. A World Bank study showed strong correlation between reduction in incidence of poverty and improved rural access. For example, in Viet Nam rural access improved significantly from an average of 76 per cent to 84 per cent at the provincial level during 2002 to 2004 and the incidence of poverty also dropped significantly from an average of 41 per cent in 1999 to 24 per cent in 2004 at the provincial level.[12]

Rural-urban linkage leads to stronger agricultural productivity; essential for achieving Sustainable Development Goal 2, which promotes food security. Most rural communities depend on agriculture (including crops, livestock, fisheries and forestry) for subsistence and income generation. The agricultural benefits of rural roads have been clearly identified in many countries. A study that analyzed large survey database in India with many variables concluded that roads contributed directly to agricultural production by 7 per cent[13].

As a component of generating economic activity, rural connectivity also plays important role for poverty reduction and improving of quality of life. A study conducted by Peter Warr in Lao PDR indicates that road improvement reduces poverty by decreasing prices of products consumed by rural households, however, the quantitative impact depends mainly on the types of road that are provided and the areas in which the road is located[14]. A similar study in India found that road construction could impact healthcare accessibility by 30 per cent[15].

Transport infrastructure and means of transport (including transport services) are both crucial to overcome the potentially fatal 'three delays' in perinatal care - making the decision to seek care, travelling to reach healthcare and then the treatment within healthcare system (including referrals to other locations)[16]. A review of global studies to highlight how poor access was a major cause of peri-natal mortality identified that an estimated 75 per cent of mortality resulted from inadequate transport to access basic health facilities and/or transport for referrals to hospitals.[17]

A review of case studies from many countries to illustrate the importance of distance, transport infrastructure and means of transport from outlying villages to health centres, and from health centres to hospitals[18]. Lack of transport access was identified as a major cause of peri-natal mortality in the hills of Nepal (where most journeys were on foot), with worst outcomes occurring among the most disadvantaged ethnic groups (thought to be associated with insufficient money and lack of awareness)[19]. Connecting villages by all-season roads in Orissa, as part of the PMGSY rural road project demonstrated concrete health-care improvements, such as people needing more serious medial attention increasingly being taken to distant hospitals rather than being treated in village health centres. Also local people felt that their well-being was better, lives had been saved and the death rate was lower.[20]

[12] Regmi, 2013
[13] Binswanger, Khandker and Rosenzweig, 1993
[14] Warr, 2007
[15] Kanuganti, Sarkar, Singh, & Arkatkar, 2015
[16] Thaddeus and Maine, 1994
[17] Babinard and Roberts, 2006
[18] Transaid, 2013
[19] Shrestha and Workman, 2008
[20] Bell and van Dillen, 2012

An analysis of the data associated with the large Indian PMGSY rural road project, suggested school attendance increased by 22 per cent a result of the new village access roads. Enrolment from disadvantaged groups ('backward castes') increased significantly.[21] Another analysis of other Indian PMGSY roads concluded that there was a 5 per cent improvement in primary educational enrolment for 5-14 year old children, without significant gender differences. However, it also identified a drop in enrolment for 14-20 year olds, which was thought to be related to greater employment opportunities for young people associated with improved road access.[22]

Despite widespread agreement on the benefits of transport connectivity, the extent of the positive impacts on development seems to vary from study to study. In contrast with the previous example there is also much evidence to suggest that the poorest rural communities often lack the resources and knowledge to take advantage of the newly accessible markets and opportunities. In fact, transport connectivity improvements do not benefit many of the rural poor because of inability to afford private transport or new public transport services[23]. Without investment in sustainable and affordable public transport taking into consideration the needs of this group they are likely to remain disadvantaged in terms of connectivity, with benefits only reaching more socio-economically advantaged households.

Therefore, whilst there is evidence to support that rural-urban transport connectivity can help alleviate poverty and promote sustainable development across the Asia Pacific region it should be understood that connectivity and development does not have a simple causal relationship. As well as physical constraints arising from lack of access and transport there are also structural constraints such as market structures and relations, cultural constraints, commercialization and poor access to enabling resources; and lack of skills, information, organization, and understanding of market operations[24]. Consequently, connecting rural and urban areas should be viewed as just one part of a multifaceted and strategic approach to stimulate sustainable economic growth in poor rural areas that will contribute to the sustainable development of the region. In summary, 'removing barriers to rural–urban mobility may enable economic growth, but the benefits will be much larger with supportive policies, markets and infrastructure investments'[25].

2.2. Measuring connectivity

In order to evaluate the effects of rural-urban connectivity on development it is firstly essential to be able to accurately estimate rural connectivity to urban centers across different regions. Road density is often used as a measure of transport infrastructure development but it is equally important to consider connectivity via road access, especially in rural areas that may be left unconnected to the existing road network. The Rural Access Index (RAI) was developed in 2006 and measures the proportion of rural population within 2 km of an all-season road [26] via rural household surveys. Data from the 2006 RAI indicated huge inequality of access within the Asia Pacific countries, from just 23 per cent rural access in Myanmar to 99 per cent in Japan. Unfortunately, the RAI has not been kept up-to-date, making a comprehensive regional comparison using the RAI difficult at this time. However, the new RAI was developed in 2016 to include spatial data to make it

[21] Mukherjee, 2012
[22] Aggarwal 2014
[23] Liu & Kesteloot, 2015; Starkey, 2016
[24] IFAD, 2001
[25] Turok & McGranahan, 2013, p.465
[26] Defined as 'a road that is motorable all year round by the prevailing means of rural transport.' Roberts, KC, & Rastogi, 2006, p.2.

more sustainable and applicable to local settings as well as national[27]and has been tested on eight countries, including two from the Asia Pacific region –Nepal and Bangladesh. Rural access in both countries has increased significantly, from 37 per cent in 2000 to 86.7 per cent in 2016 for Bangladesh and from 17 per cent 2003 to 54.2 per cent in 2016 for Nepal. Considering the developments in transport connectivity across the region it is likely that there are similar dramatic improvements in other sub regions. On the other hand, for many countries there remains a significant proportion of rural communities with very little mobility and connectivity to urban areas.

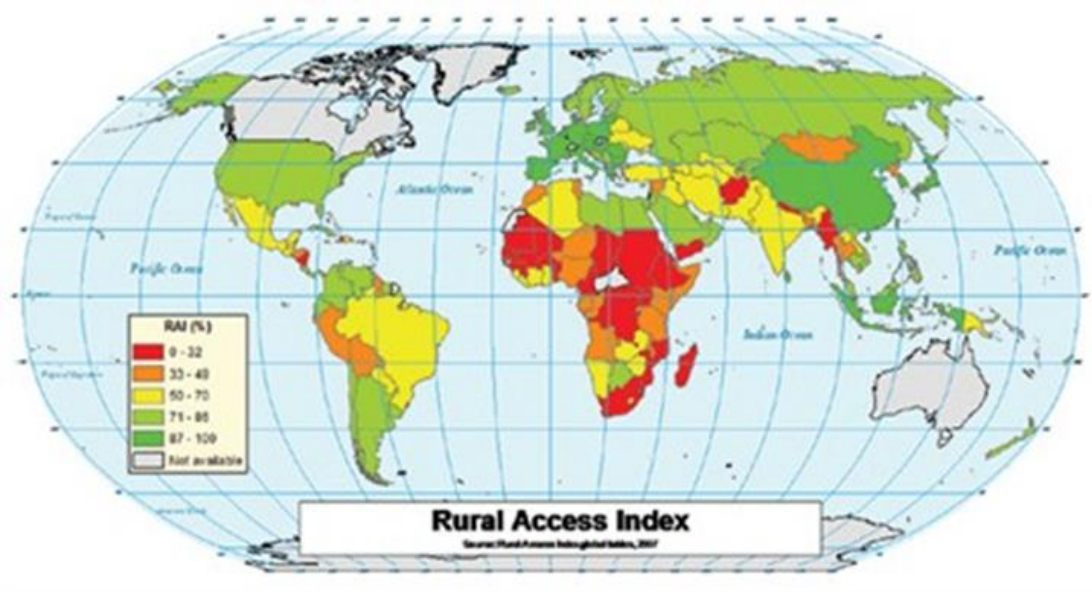

Figure 2 – Rural Access Index World Map

(Source: http://www.worldhighways.com/sections/world-reports/features/rural-roads-important-to-global-development/)

Whilst the RAI has the potential to be a very useful tool in providing an overview of rural accessibility in different countries it has some limitations in predicting access for rural communities to urban centres. First of all, as is commonplace within the transport connectivity discourse, it focuses only on road-based access and therefore discounts the importance of inland waterway transport (IWT), rail and non-all-weather roads or informal tracks. Secondly, it assumes that roads mean connectivity, and does not take into account the necessity of transport services for people who cannot afford private transport or whether the road connects to an urban centre or not. Therefore, whilst the RAI is a useful tool in measuring accessibility to roads in rural areas it cannot be used as the sole measure of connectivity between rural and urban areas and the whole travel chain including links between nodes and accessibility of transport services must be observed.

[27] Iimi, et al., 2016

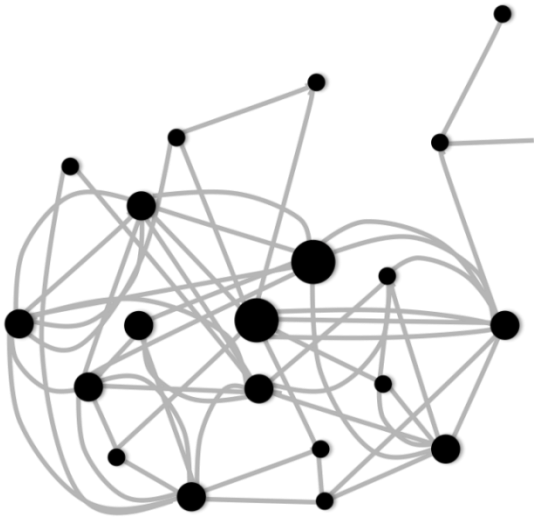

Figure 3 –Transport Connectivity Network
(Source: https://www.e-education.psu.edu/geog597i_02/node/823)

An alternative measure of connectivity is provided through the study of topological distance, or the number of connections between two nodes. Woollett, Knight, & Redfern (2009) outline the economic importance of connectivity between destinations through three elements: importance of travel time and geography; importance of trade and transport to the economic sectors; and the value of each node's economic activity centres. Using nodes (destinations) and links (connections via roads, rail or waterways) to develop a map of transport connectivity networks in conjunction with Geographic Information Systems (GIS) can provide a more comprehensive tool for transport planning and problem solving and is especially useful for local governments[28].

When planning for rural-urban transport connectivity it is appropriate to invest in proper assessment of the connectivity status quo using the data available and a combination of the aforementioned methods. This way, accurate connectivity data can inform the decisions of transport planners in directing transport investments towards the areas of lowest connectivity status for maximum network coverage.

3. Approaches to Sustainable Development and Connectivity

Sustainable development consists of three dimensions: economic, social and environmental. In order for development to be sustainable it must take into consideration each of these dimensions to meet our needs whilst ensuring that it does not compromise the ability of future generations to meet their own needs. The importance of transport connectivity as outlined in this paper relates directly to the Sustainable Development Goals (SDGs), particularly Goal 2 – end hunger, achieve food security and improved nutrition and promote sustainable agriculture; Goal 8 – sustained, inclusive and sustainable economic growth through employment and access to work; Goal 9 – resilient infrastructure for inclusive and sustainable industrialization; Goal 10 -

[28] Nagne, Vibhute, Gawali, & Mehrotra, (2013) conducted a study of GIS use in Aurangabad city, India and found that it was a useful tool for transportation facility evaluation.

reduced inequalities pertaining to mobility and migration; and Goal 11 – sustainable cities and communities, particularly supporting economic, environmental and social links between rural and urban areas.

Development disparity remains one of the main development issues in the region that is exacerbated by a lack of transport connectivity between urban areas, where administration is often centralized, and rural areas, many of which remain 'invisible' to the actors involved in development decision-making. This section examines the huge shift to urbanization and asks the question of whether urbanization is the best strategy to achieve sustainable development and how rural development and rural – urban connectivity can ease pressure on urban environments and increase contribution to the regional economy.

Almost a decade has passed since the year 2008, which marked the first time in history that more people lived in urban environments than rural ones. This is a trend that will continue and by 2050 the urban populations around the world will have doubled. Urbanization has, to date, been the main driver of economic growth within the Asia Pacific region; illustrated by the fact that 80 per cent of the region's GDP is created by the 40 per cent of the region's urban dwellers[29]. Therefore, cities offer attractive opportunities for individuals and combining with push factors of low rural incomes, instability in agricultural livelihoods and rural poverty, the results is huge rural-urban migration. The contribution of urban population growth from rural migration in the region is estimated between 25 and 40 per cent[30].

Studies of urbanization and economic growth in Africa and Asia have outlined some of the issues with urbanization-focused development. It has been shown that expansion of cities without strategic planning can lead to increased problems of congestion and overcrowding, increased pressure on ecosystems and infrastructure as well as higher costs of living, labour and property and potential environmental costs[31]. Additionally, rapid and unplanned urbanization can lead to urban sprawl, environmental problems and poor living conditions, especially in informal settlements or slums that are often located on the periphery of cities. It is estimated that one in three urban residents in the Asia Pacific region lacks proper access to shelter, safe drinking water or sanitation[32].

On the other hand, having industries and services close together in urban areas provides multiple benefits of economies of scale, whereby it is more cost-efficient than providing dispersed public services such as education and healthcare or having industries and businesses dispersed. However, if the effect of the economies of scale can be reduced, e.g. if transport links are developed to improve connectivity, then economic growth can be stimulated in areas outside of towns and cities[33]. Economic growth at the local level will reduce the aforementioned push factors for migration to cities, thereby reducing the need for urbanization and diminishing inequality by generating more even development.

Travel time is an important factor in increasing connectivity. A study in the United Kingdom showed that the benefits of agglomeration reduce sharply after forty minutes travel time to a central city[34]. Although the same travel time might not apply to Asia Pacific cities, the theory helps to explain the rise of peri-urban development in the region, in areas spatially located between urban centers and rural areas. According to

[29] ESCAP, 2013

[30] HABITAT, 2015
[31] Turok & McGranahan, 2013

[32] HABITAT, 2015
[33] Turok & McGranahan, 2013
[34] Rice, Venables, & Patacchini, 2006

Hudalah et al[35], peri-urban areas increasingly contribute to the regional economy, and in some areas even more so than the urban centers. The role of peri-urban areas could be key in offering an alternative solution to connecting rural areas to the large urban centers by reducing travel times and travel costs. However, Hudalah et al. also points out the danger of unplanned peri-urban areas becoming isolated due to a lack of connectivity. Therefore connectivity must be planned across all land-use zones, taking into consideration connectivity between rural, peri-urban and urban centers in order to ensure that links are not fragmented but integrated for maximum sustainability.

4. Transport Modes for Rural-Urban Connectivity

Rural-urban connectivity relies upon the provision of transport links to connect nodes and cover the entire travel chain – from rural households to urban or peri-urban areas, be it an employment, education, healthcare services, religious or social destination. Often, the travel chain will rely on intermodal transport that must connect to ensure the travel chain is not broken and connectivity can be achieved. The strategy for achieving rural-urban connectivity for sustainable development should utilize all modes of transport to their full potential, including intermodal transport, in order to maximize efficiency of the transport system and generate the maximum benefits[36].

Within the transport development discourse there is a tendency to overly emphasize roads as a means of improving rural connectivity. As the main and often easiest way of connecting rural and urban areas it is not surprising that roads are often prioritized in policy and planning. However, road-based transport services and other modes of transport that many rural populations depend upon are often overlooked in the study of transport solutions. Inland waterway transport (IWT) and railways are more sustainable modes of transport and should be prioritized in planning wherever possible. This paper will therefore focus not only on road development and road-based services but also rail and IWT in achieving sustainable development in the Asia Pacific region, as underdeveloped modes of sustainable transport are often used by the poorest communities in achieving mobility.

4.1. Roads

Road access is the most widespread means of connectivity between rural and urban areas and provides essential access to isolated rural communities who otherwise would have no means of reaching other areas. Road infrastructure can vary between basic trails and footpaths used by pedestrians and non-motorized transport (NMT) to national roads and highways, sometimes relying on additional infrastructure such as bridges, tunnels or ropeways in mountainous or waterway areas. Types of roads have different impacts on different levels of connectivity. For example whilst highways may connect rural and urban regions, they do not necessarily provide connectivity on the village or household level. Rural feeder roads and village pathways are an essential part of last mile connectivity for the more rural communities.

In road development studies road access is often categorized into three types; no road access; dry-weather road access; and all-weather road access, and can be measured in percentage of access as defined by the RAI. However, for larger road networks such as the Asian Highway the road quality is defined as good, fair, bad, or poor, and varies greatly from country to country, from 100 per cent rated ‘good’ in Japan to less than 20 per

[35] Hudalah, Winarso, & Woltjer, 2007
[36] Regmi, 2013

cent in Pakistan[37]. Road quality is a factor of road connectivity because poor quality or badly maintained roads can result in either a break in the travel chain (an unpassable road), or a poor connection resulting in increased travel times. Rural-urban connectivity through road investment is therefore dependent upon the type of road investment and existing connectivity status within each area.

4.1.1. Road Investment Type

Crucial to road connectivity is consideration of the level of benefits generated by roads in relation to the type of road development. Alstadt et al. (2012) differentiate between transportation cost savings, which arise from improving existing road access; and transportation-induced changes in market access, which arises from creating new connections between nodes. Both are considered as forms of connectivity and can have a considerable impact on development; however, previous research shows that the outcomes of each approach can vary. In Lao PDR upgrading areas that were not previously connected via roads to dry weather road access resulted in 17 times the reduction in poverty incidence than upgrading dry-weather roads to all-weather roads[38]. Additionally, a number of other studies both within the region and Africa showed that providing basic road connectivity in rural areas via low-grade rural roads and tracks has a greater impact on poverty reduction and national GDP than upgrading existing rural roads[39]. This indicates that creating transport connectivity between nodes that were previously unconnected can more effectively generate development benefits than increasing the efficiency (in terms of travel times and traffic capacity) of an existing connection between two nodes. Still, it should be highlighted that both types of road infrastructure development have been shown to have positive impacts on development.

Regarding road infrastructure development it is also important to consider that increasing connections between nodes within a transport network has an optimum productivity level. Once saturation of the road network has been reached the growth rates achieved through transport infrastructure becomes less significant. A study by Deng et al. in 2014[40] found that transport-led economic growth in China is influenced by highway density, or the number of highway connections between nodes in a particular area. Areas with between 0.17 and 0.38 km/km2 of highway density were found to have a more significant positive effect on economic growth, with the effects being lesser in areas with either below or above this level of density. The evidence from both studies implies that the level of economic growth stimulated depends upon the current road connectivity status in an area and the type of road development to be implemented.

Consequently, when prioritizing areas for road development it would be strategic to assess the current road connectivity status and ascertain the optimum level and type of road development from which the most development outcomes can be generated. Whilst it is apparent that poverty reduction is driven predominantly by economic growth this is often counteracted by inequality as shown to be the case in China[41]. It is therefore imperative that strategies for development are pro-poor to be in line with SDG 10 - reducing inequalities, and to avoid further depriving already disadvantaged areas by directing road development funds towards only the richer areas that are more capable of producing the highest economic returns. Larger roads such as highways must be developed in conjunction with smaller feeder roads in order to increase road coverage to the most rural areas and provide opportunities for development. However, the need for maintenance of roads also should be highlighted, as failure to maintain either low-grade rural roads or national roads and highways will

[37] ESCAP, 2015
[38] Warr, 2007
[39] Hine & Starkey, 2014
[40] Deng, Shao , Yang, & Zhang, 2014
[41] Li, 2014

result in breaks in the transport connectivity network and a reverse to isolation for communities that rely on these connections. Therefore, the empowerment of local communities in the building and maintaining of roads, including local institutions for implementation, is essential in ensuring road investment is sustainable.

4.1.2. Migration

Another of the impacts of road development for rural communities has been access to off-farm work for agricultural communities. Given that agricultural livelihoods can be unstable and agriculture-only households are likely to be poorer[42] income diversification can be viewed as a vehicle towards boosting the sustainable development of rural areas to catch up with urban centres and fulfill the aims of Sustainable Development Goal 8 for sustained, inclusive and sustainable economic growth through employment and access to work.

Case Study: Road Development, Livelihood Diversification and Migration in China

A study in China by Qiao et al. (2014) looked at the relationship between road access and off-road farm work, migration, working times and income. The data was collected using national household surveys from 625 households in 100 villages across five provinces selected to represent the major agro-ecological zones within China. The study measured road accessibility in terms of distance to the nearest highway – near (less than 0.5 km), middle (0.5-3 km) and far (more than 3 km with an average of 9.8 km) and the presence of paved roads within a village. Therefore the study focused on increasing connectivity through both existence of connection (distance to highway) and quality of the connection (roads paved or not). The results of the study showed that connectivity via road access from villages to highways has a significant impact on participation in local off-farm work, incomes, working time and permanent migration to urban centers. Villages near to highways were found to benefit from 20 per cent more off-farm employment than villages far from highways and earn 50 per cent more off-farm income. Additionally, villages with worse access had a higher proportion of migrants than villages with better access, in which inhabitants worked longer hours and earned higher incomes. The study found that villages with more individuals engaged in off-farm local work had higher per capita GVIO (gross value of industrial output) than villages with higher percentage of permanent migrants. Since the off-farm workers work longer hours and earn higher incomes it indicates travel time saved due to road expansion allows longer working hours and therefore more income. Previous studies in Viet Nam, China and Peru[43] have also shown a correlation between village connectivity via road-access and off-farm employment to supplement agricultural production, supporting the results of the China case study.

Source: Qiao, Rozelle, Huang, Zhang, & Luo, 2014

The results indicate that rural connectivity has the double effect of generating rural economic growth and rural incomes by reducing travel times and creating access to employment opportunities; and reducing the need for permanent migration to urban centres. Therefore, road connectivity can play a role in reducing disparity between rural and urban areas by increasing the economic prospects of rural residents and reducing the push factors of migration. However, road connectivity will only lead to increased economic growth if there are economic opportunities available at the destination, and therefore this should be considered alongside road investment planning.

[42] Qiao, Rozelle, Huang, Zhang, & Luo, 2014

[43] Qiao, Rozelle, Huang, Zhang, & Luo, 2014; Fan, Shenggen, and Connie Chan-Kang, 2005; Escobal, Javier. 2001; Mu, Ren, and Dominique van de Walle. 2007; Xu, Haicheng, Jian Li and Yan Yang. 2007.

4.1.3. Transport Services

Rural-urban road connectivity does not just rely on roads alone, but for many rural communities relies on the provision of transport services. When considering connectivity the actual means of movement of goods and people must be considered as well as the road links. Intermediate means of transport (IMT), including motorcycles, are often the only available forms of transport connectivity for rural areas[44]and are locally run and convenient for many rural dwellers that need to travel. Since formal services such as bus services run on national road networks only provide accessibility to rural areas that are in reasonable distance and travel time to one of these roads, the running of IMT services is an important factor in providing rural-urban connectivity, as they provide a missing link in the travel chain. Unfortunately, safety standards of many formal and informal transport services are poor due to low cost of road engineering and maintenance and difficulty enforcing road rules in rural areas, although rural people often have no choice and therefore accept substandard levels of safety[45]. Providing rural communities with road connectivity via transport services that are affordable, reliable, convenient and safe are therefore vital.

4.1.4. Road Safety

Although roads are the main method of achieving rural-urban connectivity in the region, they fail to be the safest transport option and concerns over road safety propose a significant threat to the sustainability of road transport. In order for the sustainability of roads to be improved, road safety issues must also be addressed and integrated into the planning stages for efficiency.

Road accidents are a huge concern in the Asia Pacific region, which accounts for 58 per cent of traffic fatalities worldwide. Particularly at risk in the region are vulnerable road users (VRU); pedestrians, two and three-wheeler motorized transport users, and cyclists, who together make up more than half of the region's total road deaths, which is 6 per cent higher than the world average. Additionally, it is estimated that countries across the region lose between 1 per cent and 6 per cent GDP from road crashes each year[46]. Losing family members to road accidents or permanent disablement from injury can have long-lasting economic impacts on communities, even more so in poor, rural households where members are relied upon to provide for the other members. This could offset the economic gains from road connectivity and therefore must be considered for sustainable development.

The ESCAP review of developments in transport in Asia and the Pacific 2015 reports that road infrastructure design plays a significant role in the severity and incidence of road accidents in the region, with high class roads such as the Asian Highway Class I, II and III showing reducing numbers of fatal accidents. There are a number of recommendations for improved road safety as laid out in the Decade of Action for Road Safety, in which the ultimate aim is to halve the number of road fatalities by 2020. Upgrading roads and building new roads in line with best practices for road safety could make the difference between the region's road fatality rates increasing or decreasing. One of the most vital aspects of road infrastructure design in reducing road fatalities in the region is the protection of VRU, and something that must be considered in all road development through initiatives such as separation of VRU from vehicles by separate lanes or barriers. Unfortunately, on lower grade rural feeder roads that connect to wider road networks VRU safety is not

[44] Hine & Starkey, 2014
[45] Starkey, 2016
[46] ESCAP, 2015

prioritized despite higher numbers of VRU on these types of roads. This makes VRU particularly at risk in rural areas and therefore should be a consideration in road development.

Additionally, regulation of transport services and law enforcement has a positive effect of lower frequency of road accidents and can significantly reduce fatalities. However, experts suggest that over-regulation can result in restrictions on locally operated modes of transport, which are favoured by many rural communities[47]. It is vital to come to a solution that does not compromise either safety or road connectivity for the most vulnerable groups.

4.2. Inland Waterway Transport (IWT)

A large proportion of the Asia Pacific region has the natural terrain available to support IWT and many countries have taken advantage of their rivers, canals and lakes as a means of achieving national and regional connectivity. Two of the largest navigable waterway networks in the world are located in the Asia Pacific region; in China and Russian Federation, as well as several cities built on canal networks, such as Bangkok and Ho Chi Minh City. India also has an extensive waterway system and recently passed the National Waterways Act in order to realize full utilization of 111 inland waterways[48]. Inland waterways can provide the only form of access to areas where terrain restricts provision of road or rail transportation. The terrain in Bangladesh for example, means that inland waterways provide access to 25 per cent of rural households and are the sole mode of transport for 12 per cent of the rural population. Inland waterways provide not only a means of transport but also a means of living for people living in those areas. For example, an estimated 50-70 per cent of the population in Thailand, Viet Nam, Cambodia and Lao PDR has livelihoods related to the Mekong River Commission in agriculture, fisheries or aquaculture[49]. For this reason many urban areas have historically developed around natural waterways, which provide connectivity to rural areas as waterway sources usually begin in mountainous rural areas.

The World Bank categorizes IWT into national – mainly large freight and passenger services linking main ports and economic centres; local – providing community to community mobility and usually passenger services but small freight; and ferries, which are more part of the road system as they provide para-transit in the absence of bridges[50]. Navigation of inland waterways relies on water levels, waterway width, and visibility, which can be extremely vulnerable to climate change and weather conditions. Additionally, waterway infrastructure and technologies are vital to safe navigation, docking and loading, and may require a lot of financial investment before inland waterways can be usable as transport systems. Many waterways in the region therefore remain in their natural form and are not fully utilized for freight transportation, despite IWT offering many benefits as an alternative to road, including lower costs, increased efficiency and lower emissions.

The second high-level workshop on IWT[51], presented shared IWT system experiences and key challenges from experts from around the world. Each of the state attendees had interests in developing IWT to support the

[47] Starkey, 2016
[48] Press Information Bureau Government Of India, 2016
[49] Mekhong River Commission, 2015
[50] World Bank, 2009
[51] Organized by the Asian Development Bank and attended by 11 Asia Pacific countries – see Asian Development Bank, 2013

development and connectivity, with three countries, namely Papua New Guinea, Bangladesh and Pakistan, outlining the importance of IWT for rural connectivity in their country contexts. Countries in the Asia Pacific region are beginning to realize the potential of IWT for contributing to sustainable development but there are still several issues preventing IWT from reaching its full potential in providing transport connectivity. These include but are not limited to political and geopolitical issues in raising the profile of IWT and facilitating collaboration of relevant communities in its development; the need for technology for safe navigation and development of sustainable IWT infrastructure; environmental issues including pollution and water management; and a need for emphasis on policy and planning integration between the relevant stakeholders.

4.2.1. IWT Investment

There is an argument for infrastructure subsidies for IWT in that it provides a cost-effective, environmentally friendly, safe and efficient means of connecting rural, urban, and peri-urban areas. IWT for the transportation of bulk cargo of natural materials supports rural industries by connecting them either directly or indirectly to urban areas and generating employment. For example, a World Bank project improved 33 km of inland waterways in China with the specific objective of enhancing the quality of life in the Han region and general objective of improving the connectivity of inland provinces[52]. The project widened waterways to increase connectivity efficiency by enabling the use of larger vessels for transportation of cargo at lower cost. Additionally, 6 water turbines were installed for hydropower generation. These inputs resulted in reported outcomes of 53 per cent increase in the amount of waterway traffic and an increase in per capita income of families resettled by the project from just over 3,000 to over 5,000 Yuan. Furthermore, an estimated 322, 800 tons of C02 were saved through implementation of the project. Whilst the Economic Internal Rate of Return (EIRR) of 21.3 per cent was almost the same as the projected, the financial rate of return of 1.4 per cent was much less than the projected 6.0 per cent. IWT has the potential to be highly effective in terms of development outcomes despite the possibility of smaller immediate financial returns.

Network, infrastructure and user design are key features of designing sustainable IWT systems that are attractive investments. A project for community waterway transport in Papua New Guinea[53] was implemented in 2004 with the aim of reducing poverty of rural river and coastal communities through connectivity. The project consisted of several phases including developing a trust to manage finances, a community support project, implementing IWT safety standards and developing and restoring IWT infrastructure. Some measures of the program were successful, notably the improvement of safety standards by introducing a boat registering system, radio network and safety equipment. However, other aspects were not so successful. During the development of waterway infrastructure phase the original plan to develop 40 old jetties was discarded in favour of construction of 6 new jetties, doubling original estimated project costs from USD 4.1 million to USD 8.5 million actual cost[54]. Unfortunately, lack of design consideration resulted in the new jetties being unsuitable for many vessel types on existing franchise routes, unusable for the majority portion of the year when water levels are low, and unsafe during this period due to lack of safety handrails. The Papua New Guinea case illustrates that it is imperative to thoroughly analyze the existing service and network user needs in order for new or upgraded infrastructure to produce the most efficient development outcomes and returns.

[52] World Bank, 2013
[53] Asian Development Bank, 2014

[54] Higher costs were covered by the PNG Government.

4.2.2. IWT as Indigenous and Sustainable Transport

IWT is also a form of informal transport, which encompasses many indigenous features– homegrown, locally operated, socially accepted, culturally appropriate, adaptive to technology, additionally it is responsive to demand[55]. Whilst it is highly unlikely that IWT will be able to compete with roads, in areas where road access is difficult IWT can provide the only means of access and therefore has potential to be a sustainable, alternative method of rural-urban transportation. However, IWT still remains very underdeveloped and underused in the region[56] and faces numerous problems including pollution, impact of climate change, lack of funding from governments and safety issues. Development of IWT should therefore focus on solving these issues to enhance the economic, ecological and social sustainability of these systems. In order for IWT developments to be both successful and sustainable the accessibility needs of the users and existing modes of transport should be carefully considered, including factors such as cost, location, access needs and design inclusivity. Enhancing existing transport infrastructure can often be more cost-effective, especially if the existing systems possess indigenous features that support sustainability.

Case Study: Sustainable and Indigenous Inland Waterway Transport in Southeast Asia

Utomo & Mateo-Babiano (2015) review IWT in the Southeast Asia region, notably the Mekong Delta in Viet Nam and the inland waterway systems of Banjarmasin, Indonesia; both of which link cities and peri-urban zones with surrounding rural areas. Both waterway systems have a number of indigenous features in common. They have both been noted to provide connectivity to places that have no other transport infrastructure and despite declining usage IWT is still used by many communities as a means of transit or para-transit to farmland, markets, education, employment and social acitivities. Because of its local operation IWT fills the gap left by other modes of transport; providing wider coverage at affordable prices to vulnerable groups. The authors note that IWT in these areas is also a tourist attraction, as well as local IWT operation providing income for lower income households. The results of the study conclude that the indigenous aspects of IWT in both Viet Nam and Indonesia contribute to the sustainability of the systems. In comparison, less successful IWT systems such as the Pasig ferry service in Manila were found to possess fewer indigenous features and saw environmental, safety and financial viability issues that resulted in repeated closure of the service. The Pasig ferry service was somewhat more modern, expensive to use and served only urban areas of Manila thus competed with other modes of transport, particularly road. Additionally, confusing timetabling meant that passengers eventually moved to other modes of transport that were more efficient.

Source: Utomo & Mateo-Babiano (2015)

The comparison between the Mekong Delta and Banjarmasin and the Pasig ferry cases is a good illustration of how IWT systems that cater to the needs of users and provide mobility where there is no other means of transport can be sustainable modes of achieving connectivity. Both of the successful IWT systems had been developed locally and adapted to meet the needs of the users. However, there were still some issues regarding access for women, particularly in the case of the Indonesian IWT system, many of whom were concerned about safety and inconvenience. Lack of women's mobility and access to transport is widely recognised as a critical development issue that must be resolved. IWT offers opportunities to enhance the mobility of women and children to services as well as offering employment opportunities for women, however their specific needs

[55] Utomo, D. M., & Mateo-Babiano, I, 2015; Cervero, 2000
[56] Asian Development Bank, 2013

must be considered in the design of services and infrastructure[57]. The same consideration should also be extended to other disadvantaged user-groups such as disabled and elderly people who are more at risk of poverty and lack of mobility, exacerbated by lack of access to existing transport services. Inclusion of all groups in transport accessibility is essential to gain maximum returns transport developments and ensure the contribution of these groups to the national and regional economies.

4.2.3. Environmental Issues with IWT

Although considered to be one of the most environmentally friendly transportation options IWT still presents a range of issues in regards to environmental sustainability, particularly in relation to water use and pollution. It is no secret that Asian waterways suffer from extreme environmental degradation and are some of the most polluted waterways in the world. This seriously threatens the sustainability of transportation systems that have the potential to offer much a more environmentally friendly method of transport connectivity than road transport. This was illustrated above in the case of the Pasig ferry, in which problems with water pollution resulted in the service's repeated closure, despite efforts to restore the waterways to a satisfactory level.

Other forms of pollution can arise from the use of IWT asides from water pollution. Commuters on Bangkok's canal long tail boat service are exposed to high levels of carbon monoxide, black carbon and noise[58], which is worrying from both a health perspective and an environmental one. Whilst Bangkok's canal service is considered to be a successful transport method in considerably reducing travel times, providing the many indigenous features that support sustainability and helping to relieve road congestion, the offsets in the form of environmental and health impacts cannot be ignored. Efforts should be put into developing clean energy solutions for the running of IWT so that these effects can be mitigated. In regards to sustainability IWT should be viewed as part of a wider system of water use. The development of IWT needs to be integrated with planning for the entire water system so as not to compromise the other uses of the water system, including for drinking water, irrigation and hydropower[59].

4.2.4. Regulation of IWT

Regulation of IWT is essential to mitigate threats to the sustainability of such a promising transport system. There is a need for policy frameworks to guide the regulation and safety, environmental and technical standards required for co-ordination and successful operation of IWT in the region[60]. With much IWT for passengers being operated locally, there is a need to improve safety measures without over-regulation that will compromise the indigeneity of existing IWT systems and thus the mobility of the people who rely on them. Regulation should also ensure that IWT is equally accessible for disadvantaged groups, with specific focus on women, the disabled, the elderly and the young. For regional development to be sustainable all groups must be included in transport access in order to facilitate the contribution of all groups to the local, national and regional economies.

Waterway safety is something that was developed somewhat successfully in the case of the Papua New Guinea IWT project. IWT offers a much safer alternative to road travel by reducing the number of vehicles on the roads, however if IWT use is to increase the possibility for accidents to increase is also apparent. The

[57] Asian Development Bank, 2013a.
[58] Velasco, Ho, & Ziegler, 2013
[59] Asian Development Bank, 2013
[60] Asian Development Bank, 2013

implementation of safety regulations, equipment and education to improve safety standards needs to be included in the planning stages of development of IWT systems within the region.

4.3. Rail

Rail travel is widely recognized as an alternative mode of transport that offers several competitive advantages when compared to road and IWT. Rail offers a cheaper alternative to road transit with less congestion, higher levels of safety, lower energy consumption, lower CO_2 emissions and less air pollution, except in the case of diesel trains[61]. On the other hand, rail has several restrictions that make it less applicable to the context of rural-urban connectivity including low flexibility and lower levels of access than road transport. Rail transport is therefore a means of linking rural and urban regions, and high-speed rail (HSR) has particularly helped to facilitate the movement of rural-urban movements caused by economic changes in countries such as China[62]. But rail for rural-urban connectivity is often implemented on this larger scale rather than a small local scale due to non-feasibility of connecting rail networks to small rural communities without the use of intermodal transport, e.g. road connections to stations.

China is at the forefront of rail development in the region and has implemented several major rail development projects with the aim of increasing national connectivity, especially to the landlocked provinces. Many of these projects have been successful and generated employment and local industry development, especially in areas of rail construction whereby locals have been employed as labourers working on the railroad.

Case Study: China: Taiyuan–Zhongwei Railway Project

The Taiyuan-Zhongwei railway project was an ADB project aimed at providing connectivity between China's poorer Eastern and richer Western provinces. During the 4 years of construction of the Taiyuan-Zhongwei-Yinchuan Railway gross regional product increased between 52 – 189 per cent in the provinces where the rail line was located. Whilst this increase was likely to be due to business generated by the rail construction itself, an project evaluation undertaken two years post-completion showed that the project successfully narrowed the income gap between poor and rich counties and stimulated external investment in previously isolated areas through tourism and industry. A notable example is the Lvliang Prefecture, which attracted about CNY500 billion external investments in 2011 and 2012. Other development outcomes included a rise in the per capita income of farmers by 103 per cent–265 per cent in counties and cities along the railway.

Source: ADB, 2012; ADB, 2014a.

The China case-study is an example of how rural-urban transport connectivity through railways can help to alleviate disparity between rich and poor areas through stimulating economic growth and investment. However, results from another China study queries the ability of all types of rail in providing equality of access for the poorest areas. A study on the development of High Speed Rail (HSR) in China reported that HSR tickets are too expensive for poor rural workers and therefore restrict their ability to reach urban areas. High fares lead to reduced mobility, which then results in reduced economic family ties as migrants are forced to stay in cities[63]. In comparison to the case-study of rural road access in China that discouraged migration, transport connectivity that is not cost-accessible for the very poor can have the opposite effect. Therefore cost

[61] ESCAP, 2015
[62] Liu & Kesteloot, 2015
[63] Liu & Kesteloot, 2015

is an important consideration to ensure transport systems support the sustainable and even patterns of development by bringing accessible transport connectivity to the poorest communities.

5. Conclusions and Recommendations

There has been huge improvement in regional connectivity in the Asia Pacific that has helped to accelerate the growth and development of the region in the recent past. However, this development has been largely unequal, with urban centres experiencing faster rates of growth and development than rural areas, which are being left behind. This disparity has been one of the push factors for mass migration and in addition to urban-concentrated growth has contributed to issues plaguing cities and urban zones. Increasing connectivity and reducing travel times between central urban zones and outlying rural areas can reduce the effects of economies of scale and reduce push factors for migration by stimulating economic growth outside of urban zones.

Considering the evidence reviewed in this paper for the connectivity of rural and urban areas in the Asia Pacific region the following recommendations are suggested to contribute to the achievement of the Sustainable Development Goals:

5.1. Integrate rural-urban connectivity with rural development plans

Rural-urban transport connectivity does not necessarily equate to even and sustainable regional development and in some cases can even exacerbate the push factors leading to rural-urban migration. Transport connectivity for maximum economic growth is likely to benefit the already economically advantaged households and further disadvantage the poorest. Therefore it is imperative that policies that promote sustainable and even development to minimize disparity, through integration with other rural development initiatives.

5.2. Strategically expand connectivity of the transport network

Research suggests that the most beneficial development outcomes come from expanding the existing transport network via building new linkages. Therefore, connectivity strategies should have a dual focus; development or rejuvenation of existing and indigenous transport networks in order to provide the most sustainability; and investment in new transport connections that link rural areas to the wider transport network.

5.3. Improve measures of connectivity

Informed planning and policy decisions are key for sustainable transport systems. Accurately measuring connectivity is essential for the strategic planning of improving and expanding the existing transport network and identifying the optimal point for investment. There are limitations to the sole use of the RAI in measuring rural-urban connectivity but utilizing GIS technology connectivity mapping can enhance this.

5.4. Encourage long-term investment into IWT for rural-urban connectivity

Barriers facing sustainable connectivity solutions include lack of prioritization of alternative solutions such as IWT. Since these solutions often require a lot of initial financial investment and long-term development they do not always gain a lot of political attention, despite the huge potential benefits for sustainable development.

Initiatives such as the ADB's IWT workshop can help to highlight the importance for countries and generate collective solutions to overcome barriers to investment and implementation.

5.5. Develop sustainable and accessible transport services

In order for the benefits of connectivity to reach the most disadvantaged households affordable and accessible transport services must be provided for new and existing transport links. This may take the form of local authority-run bus services, intermediate modes of transport such as motorbike taxi, or locally run boat services. Where possible, further development of clean and safe indigenous rural-urban transport connections should be prioritized to maximize accessibility and sustainability, e.g. making inland waterway transport accessible for all user-groups, especially women, children, the elderly and the disabled. Regulation should be implemented to maximize efficiency and improve safety standards without compromising the mobility of users.

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