Marion Aschmann[1*]
[1] University of Stuttgart, Institute for Economics and Law, Stuttgart, Germany
*** Corresponding author:** aschmann@ivr.uni-stuttgart.de

ADDRESSING AIR POLLUTION AND BEYOND IN ULAANBAATAR: THE ROLE OF SUSTAINABLE MOBILITY

ABSTRACT. All over the world the transport sector contributes to local air pollution as well as CO_2-emissions and transportation related problems such as congestion especially in urban agglomerations. In Ulaanbaatar traffic is currently not the most important source of air pollution but it will gain importance due to a growing demand for transport and related effects. A transformation towards sustainable mobility is therefore needed which is pursued by reduction of the number of trips, influencing the modal split towards more sustainable modes and more efficient handling of mobility.

This paper discusses different characteristics of air pollution, traffic congestion and CO_2-emissions and respective suitability of policy instruments. It is argued that conducting mobility more efficient will be not enough to address all relevant effects of growing demand. In doing so special attention is given to the interaction of built environment, land use and transport as well as related planning approaches which is particularly important in a situation when urban growth has to be managed.

A transfer towards sustainable mobility needs a two-step approach: a more short-term improvement related to a more environmentally friendly transport system and a long-term approach to organise urban mobility in a sustainable way by adopting an integrated urban and transport planning and influencing transport behaviour.

KEY WORDS: External costs of transport, sustainable mobility, integrated urban and transport planning, transit oriented development, policy mixes for sustainable mobility

CITATION: Marion Aschmann (2019) Addressing Air Pollution And Beyond In Ulaanbaatar: The Role Of Sustainable Mobility. Geography, Environment, Sustainability,
Vol.12, No 3, p. 213-223
DOI-10.24057/2071-9388-2019-30

INTRODUCTION

The air pollution problem on the Mongolian plateau is long known and experienced every year especially during the heating period. Main sources of pollution in the capital city of Ulaanbaatar are identified as coal burning in gers (the traditional local tents), industrial emissions, household heating as well as emissions from public and private transport among other sources (Amarsaikhan et al. 2014, p. 124). The contribution of motor vehicles is estimated at around 10 % (WHO 2018, p.2). A specifically high contribution of the transport sector can be stated regarding NOx, the share of transport amounts to 33 % in 2010 (see Guttikunda et al. 2013, p. 594), with a strongly growing number of vehicles (see also under 2.). A recent study conducted to prepare an air quality improvement program states the causes for the low level of air quality on a general level: the study identifies the increasing number of private vehicles and polluting public buses as a part of a highly polluting urban system among inconsistent energy and environmental policy as well as uncoordinated urban development (ADB 2017, p.9).

Additional to the man-made sources there also is a specific sensitivity of the area, in Ulaanbaatar the local air pollution is enhanced by location and topography. The weather phenomenon known as thermal inversion occurs frequently (Amarsaikhan et al. 2014, p. 125). It is characterised by a layer of cooler air near ground level which is covered by a layer of warmer air. This leads to a low degree of mixing of the layers and pollutants remain in the lower layer.

But addressing the transport system is not only important because it contributes to local air pollution and causes accompanying CO_2-emisssions. The rapid growth of the Ulaanbaatar urban area together with a growing number of private vehicles and the existing overloaded public transportation system cause undesirable effects other than emissions. It is also the root of congestion and traffic safety problems.

The next section discusses the existing situation regarding urban mobility and its related problems and derives the goal of sustainable urban mobility as a long term development opportunity.

GOAL OF SUSTAINABLE MOBILITY

Mobility of persons and goods is generally associated with positive effects: mobility of persons is crucial for social co-existence whereas mobility of goods is a precondition for a functioning economy based on division of labour. These effects of mobility regarding persons or goods are strongly related to the concept of accessibility: activities (e.g. home, work, leisure activities) take place in different locations whereas goods need to be transported between production facilities or to the consumers. Mobility then represents those movements conducted as trips between origins and destinations.

Negative effects of mobility relate to road traffic with private and heavy-goods vehicles. This also puts a strain on the environment and health of people especially in metropolitan areas and restricts the quality of life of urban residents. Quite often especially lower income neighbourhoods are affected, whose residents show a high degree of vulnerability which means that they are less able to cope with the situation. This is also the case for Ulaanbaatar and lower income ger districts (see ADB 2017, p. 9).

Though the situation in metropolitan areas differs according to the local conditions, local air pollution along with heavy congestion is seen as major challenges in many Southeast Asian cities by the International Transport Forum (ITF 2017a, p. 158). There is additionally an increasing transport demand with no signs of slowing down plus high vehicle growth rates for cars. Projections say that the share of private cars continues to increase strongly in developing regions and falls only slightly in developed countries (ibid, p. 13). Though increases in motorisation will bring positive benefits and contribute to economic growth, high levels of

congestion, energy consumption, local air pollution, and CO_2-emissions will often follow (ibid, p. 157). Although this analysis is related to Southeast Asian countries, the results most likely also hold for Mongolia and especially Ulaanbaatar. Empirical research shows increasing car ownership rates with increasing income as a global trend.

This trend can be confirmed on the basis of information on registered vehicles in Ulaanbaatar though the data source is limited. Zhamsueva et al. state an increase in vehicles from 2005 to 2013 from 75 000 to 300 100 (see Zhamsueva et al. 2018, p. 270), which corresponds to a compound annual growth rate of 18.93 %. More recent information from the Ulaanbaatar Traffic Control Centre states more than 480 000 registered vehicles in Ulaanbaatar in 2017 (see Seaniger 2017). Correspondingly the compound annual growth rate equals 12.46 % for the time period 2013-2017, still representing a high growth rate fuelled by population growth on the one hand and growing income on the other. A huge increase in car ownership especially for middle-income Mongolians is also attributed to the low price of imported right-hand drive vehicles (see ibid).

Regarding the importance of mobility as well as the continuing growth of the transport sector a transformation towards sustainable mobility is needed to overcome the negative side effects. The transport related targets can be linked to the UN Sustainable Development Goals. Since transport and mobility are cross-cutting issues there is no single mobility target but a number of goals which are affected by transport. Transport and mobility in general should be organised in a way that the sustainability goals are supported without restricting the possibility for economic development.

The higher-order sustainability goals need to be translated into operational targets. The most relevant goal related to urban mobility is "Good Health and Well-being". It is pursued with the targets to reduce accidents and their consequences as well as to reduce deaths and illnesses from pollution. Another very important goal is "Sustainable Cities and Communities" with the targets to provide access to safe, affordable, accessible and sustainable transport systems for all and to reduce the adverse environmental impact of cities. Beyond that transport related targets focus on climate change and energy efficiency (High-level Advisory Group on Sustainable Transport 2016, p. 11). As argued, sustainable mobility is an important field of action in a long term strategy to achieve a more sustainable city. Though sustainable transport also encompasses social and economic aspects such as affordability or operational efficiency the main focus of this paper lies on the ecological dimension.

EXTERNAL COSTS AND POLICY INSTRUMENTS

Characteristics of external costs

In the first place an efficient strategy should combine various instruments to reduce the negative impacts of mobility and transportation. These negative impacts are often so called external costs: in economic terms negative externalities are costs that affect a third party who did not choose to take it and which are not reflected in the prices. Related activities impose costs on society which are not or only partly taken into account when making the decision. For the transport sector the focus usually lies on negative externalities such as accidents, local and global emissions as well as noise and congestion costs. Some externalities occur within the transportation sector (such as congestion) whereas others arise locally and harm the respective residents within the area of influence (such as pollution by particulate matter) or even have a global impact (such as CO_2-emissions).

The priority of reduction should be targeted to those external costs which are seen as most pressing for rapidly growing cities in Asia as aforementioned. The following tables base on this selection and show the different types of external costs.

Shown are the related cost aspects and valuation issues as well as their functional relationship with the transportation system and by which factors they are mainly influenced or determined. The variation in the characteristics, especially regarding the linkage to the transport system and main drivers, lead to the fact that policy instruments vary in their suitability to address the different external effects. The differentiation is therefore needed to determine policy or policy mixes. The characteristics listed below base on a detailed study on external costs of transport for the European commission (edited based on Ricardo-AEA 2014, p. 8f.).

Currently these effects are the main concern in Ulaanbaatar and cause an urgent demand for action, all main cost drivers are a critical issue. Congestion costs as well as CO_2-emissions will become more pressing as transportation demand will increase over the next years.

To fully understand the problem with congestion costs it is necessary to distinguish among social costs and private costs in more detail. Private costs incur at the transport user and are considered during the decision process, such as fuel cost or transport fare, but also own time costs (Ricardo-AEA 2014, p. 8f.). The impact on other transport users is not included in these private costs. The time costs by an additional vehicle (so called marginal costs) imposed on the other road users (and additional operating costs due to congestion) are therefore external costs. These costs of time losses affect private as well as commercial users can amount to a significant total welfare loss of a society. Both types of additional costs so far discussed are born by users within the transport sector. Outside the transport sector e.g. environmental costs occur in a congested situation: increased air pollution due to higher fuel consumption and noise harm the nearby residents. These cost types have strong distributional effects.

For CO_2-emissions efforts and related costs to reduce them occur on a local level whereas the benefits of reduction ensue on a global scale which limits the readiness

Table 1. Local air pollution

Cost elements	Functional relationship	Main cost drivers
• Health costs, years of life lost, crop losses, biosphere costs … • Critical valuation issues, especially regarding long-term risks	• Correlation with traffic volume, level of emission and location • Strong spatial and temporal effects (hotspots)	• Population and settlement density • Geographical situation / sensitivity of an area • Level of emissions depend on • Type and condition of vehicles • …

Table 2. Traffic Congestion

Cost elements	Functional relationship	Main cost drivers
• Time and operating costs (within transport sector) • Safety and environmental costs • Critical valuation issues, especially regarding value of time	• Increasing marginal cost in relation to traffic amount • Depending on time / location	• Type of infrastructure • Relation of traffic volume and capacity, mainly depending on • Time of the day, location, accidents …

Table 3. CO_2-Emissions

Cost elements	Functional relationship	Main cost drivers
• Prevention costs and damage costs • Critical valuation issues, esp. long-term risks	• Costs are proportional to • traffic amount • and fuel used • Effects are independent from location or time of emission	• Level of emissions depending on • Type of vehicles and additional equipment (e.g. air conditioning) • Speed characteristics • Fuel use and type …

to cut back these emissions. Reduction might not be a major concern in Mongolia right now but gain importance in the long term and should therefore be considered.

Detailed knowledge about these effects is required to judge the suitability of policy approaches which deal with the main cost drivers but also the functional relationship and a necessary precondition for the design of strategies need to be considered.

Measurement of these external costs is driven by the need for action or monitoring requirements regarding the evaluation of policy instruments at a later stage. Additional monetary assessment of physical indicators is no precondition though it shows the relative importance of the related issues and helps to evaluate instruments regarding their cost efficiency. The total welfare loss of a society is not only determined by the total impact but also by the valuation decisions. For congestion cost the value of time for private as well as commercial users in the transport system has to be estimated, the latter e.g. on the basis of respective average labour cost. Due to this aspect all cost rates have to be determined or adapted for a specific region or country.

External costs and policy instruments

Goals of sustainable mobility are pursued by three general approaches: reducing the number of trips, influencing the modal split towards more sustainable modes and conducting trips more environmentally friendly, usually by increased efficiency of vehicles.

The most important direct approach to address negative external effects of transportation is the introduction of legally binding regulations. Regulations such as EU emission standards for new vehicles limit polluting emissions and aim at enhancing specific technological progress, other regulations such as the EU directive standardising the quality of petrol and diesel fuels define standards and focus on quality control. The other prevalent approach is public spending with the objective of increasing the share of public transportation, e.g. provision or extension of infrastructure capacity or subsidies for public transport operation. To be distinguished from these are market-based instruments which influence relative prices such as taxation of energy sources or motor vehicle taxes (Brenck et al. p.418). Additional instruments can be adopted on the local level, e.g. driving restrictions or parking regulations.

The advantage of regulatory instruments is that the reduction in terms of ecological effects is more reliable and the occurrence of hot spots can be prevented; both aspects make them suitable for local air pollution. Another positive aspect is the implementation which is comparatively easy and cheap if institutional capacity is available (ibid, p.418). Notwithstanding regulatory instruments also have a main disadvantage, there is no or only a weak link to abatement costs. This can lead to a low cost efficiency, especially for CO_2-emissions where reduction in the transport sector is comparatively expensive (and correspondingly reductions in other sectors cheaper). For other pollutants there are well established solutions with a high penetration of the respective vehicle markets.

Main concern of public spending in terms of public transport provision and related subsidies is to provide accessibility for urban residents, investment in public transport support indirectly affects external effects by influencing the modal share. Though this is always a costly option, increased capacity and utilisation of rail-bound systems e.g. in Europe, as well as introduction of new mass transportation systems in other parts of the world is a necessary precondition to enable the choice of a more sustainable mode.

Economic instruments aim at the price of using environmental resources, related instruments are input or pollution taxes, e.g. differentiation of petroleum tax or motor vehicle tax varying according to emission levels. An advantage of these policy instruments is that they influence demand not only related to the buying decision but also the general demand in terms of kilometres travelled. This advantage is only lost if the respective markets barely respond to pricing or high transaction costs (e.g. for implementation or enforcement of this policy) occur (ibid, p.418). But depending on the price elasticity of demand also leads to the fact that demand reaction can only be anticipated and the ecological effect cannot be controlled. Pricing instruments therefore should only be part of a strategy to reduce local air pollution.

A benefit of pricing strategies is that they are able to generate public revenues which can be used to for improving the public transport situation; on a local level this is one of the main arguments in favour of road pricing schemes.

As already mentioned regulative instruments can reliably reduce local air pollution: in Europe emission regulations regarding emission levels of new vehicles and regulation of the quality of petrol and diesel fuels effectively reduced air pollution. The legislative authority required stepwise lower emission levels for new vehicles and thereby caused the manufacturers to develop a more efficient technology for motors and emission control. Secondly, the quality of fuel was improved by an EU directive. This led to a significant decrease of specific emissions by pollutants and CO_2-emissions relative to the person kilometres travelled during the last twenty years as shown for Germany in Fig. 1 (German Environmental Agency eds. 2018). A similar relationship could be illustrated by showing the increasing efficiency of freight traffic with an even more distinct decrease. In both cases the increase in trips consumes the efficiency gains and correspondingly the total emission reduction is always lower than reduction in specific emissions.

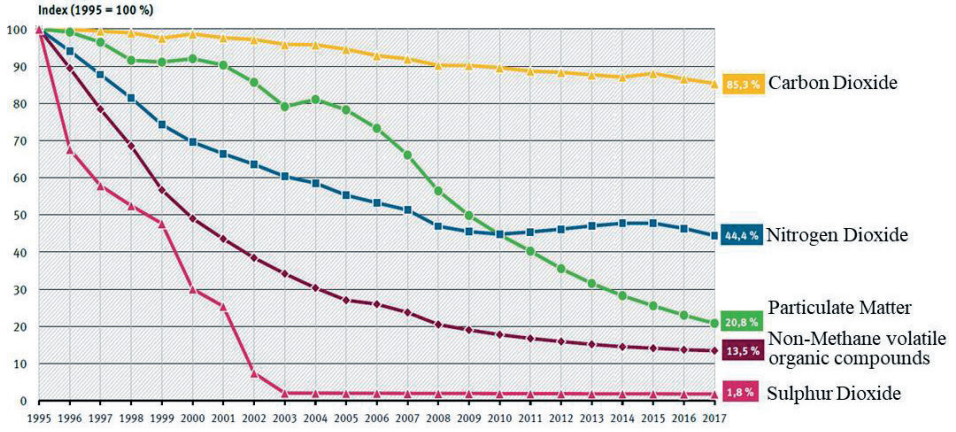

Fig. 1. Specific emissions by private vehicles (direct emissions/person kilometres travelled). Source: German Environmental Agency (eds. 2018), URL see references Data and calculation model TREMOD Transport Emission Model, Version 5.81 (01/2018) based on standardized emission factors for road transport

As can be seen in figure 1 the transport sector remains to be an important source of NO_x and particulate matter as well as CO_2. The effort to influence the modal split by public investment in sustainable modes is increasingly successful in an urban context, but emission reduction within the transport sector remains a crucial issue.

Transformation towards sustainable mobility especially in the context of urban mobility therefore requires more than better vehicle and fuel technology, relying on efficiency only will not be sufficient. Efficiency gains reduce the vehicle operating costs, which encourages an increase of total annual kilometres travelled, the actual fuel saving lies below the theoretically possible. This so called "rebound effect" has been identified and estimated by a number of empirical studies. The size of the effect reflects the elasticity of vehicle travel with respect to fuel price. Although there remains a net reduction in fuel consumption, the increased demand tightens other transport related problems such as pollution, congestion, road and parking facility costs and urban sprawl (VTPI 2017). The rebound effect thereby intensifies the problems of a continuously growing motorisation rate. The saturation level regarding the vehicle kilometres travelled can only be estimated for Mongolia but is most likely far from being reached yet, the same holds for the car ownership (motorisation) rate.

Ignoring the above characterised rebound effect leads to overestimate the impact of instruments which influence the efficiency of new vehicles, such as fuel efficiency standards, and to undervalue the effect of instruments which address vehicle use, such as transport management and pricing strategies, as part of an emission reduction policy mix.

Transport and built environment

The policy instruments discussed so far aim at two of the three mobility goals: efficient handling and thereby reducing external costs directly as well as a shift towards more sustainable modes. These instruments should be backed up by a mid to long-term strategy which aims at an integrated land-use and transport planning since built environment is a major determinant of travel demand and mode choice. „If travel distances, traffic congestion and traffic pollution are to be reduced there must be coordination between transportation, housing and land use programmes. Urban development should be managed so as to reduce future traffic loads and promote growth travel efficiencies" (Cervero 2003, p. 66).

As stated above there is a strong relationship between land use and transport demand in terms of trips and kilometres travelled: Distribution of land uses in a city determines the distribution of activities and this creates demand for transport. Transportation infrastructure enables transport and provides accessibility of the different activities. Accessibility on the other hand also determines location decisions and influences changes regarding the land use.

If growth is not managed by integrated planning a trend to higher car dependency arises over time: the settlement structure becomes more scattered and users as well as planners become less sensitive to distance (and time). Growing car dependency results in a growing motorisation rate followed by investment in infrastructure for private transport which leads to increasing distance travelled.

A higher car dependency of the settlement structure is reflected in a lack or uncomfortable access to public transport, an unfavourable travel time ratio (public versus private transportation) and inconvenient accessibility of opportunities for activities by public transportation. This again fuels car dependency but also leads to low accessibility of satellite towns or scattered settlements.

Shaping settlement growth therefore is a crucial issue especially in areas with a high rate of urbanisation. The way how and where growth is accommodated determines to a large extent if a region is transit-supportive. An integrated strategy to manage settlement growth bases on "transit oriented development". With the backbone of a functioning mass transit system this planning approach focuses on built environment factors which positively influence the reduction of private trips and vehicle kilometres per capita as well as enhance public transit ridership. The most important factors are "five D's": Settlement Density, Diversity of land-uses, Design of urban environment (walkability), Destination Accessibility and Distance to transit (Ewing and Cervero 2010). Transport oriented development is often based on rail-bound systems, but other mass transit systems such as grade separated bus rapid transit systems provide a cost-efficient urban mobility solution and require a lower optimal residential density (Falcocchio and Levinson 2015, p. 367).

Pursuing the integration of land use planning as well as development on the one hand and transport planning on the other for a "Transit Oriented Development" is the aim of many planning authorities: concentrating urban development next to mass transit stations to support public transit ridership and developing transport systems to connect existing and planned development hubs. By increasing PuT accessibility alternatives to land uses based on private motorised transport accessibility are created and current urban mobility becomes more sustainable, which has the positive side effect of improving urban quality of life (Bertolini et al. 2016, p. 3).

There is extensive literature discussing the background reasoning of integrated planning as well as pursuing "smart growth" or "transit oriented development". Increasingly there are also best practice examples related to coordinated approaches of land development and transportation (Curtis et al 2016, Falcocchio and Levinson 2015). Recommendations refer to measures such as zoning (concentrated retail activities instead of strip development along major transport arteria) or how activity centres can be designed to provide of multi-modal access (Falcocchio and Levinson 2015, p. 378ff.).

RESULTS AND DISCUSSION: POLICY MIXES FOR SUSTAINABLE MOBILITY

To move towards an environmentally friendly transport system and in the long run to achieve sustainable mobility two goals can be identified: enhancing the efficiency in handling transport activities and influencing the demand for transport in terms of number of trips and modes used. Regulatory instruments such as efficiency standards influence external costs directly: they reduce air pollution, avoid the emergence of hotspots and can lead to a significant decrease of specific emissions for both private and commercial vehicles (see the positive effects of EU emission levels for new vehicles and regulation of the quality of petrol). The disadvantage refers to the fact that these measure only relate to the buying decision, there is no influence on the use.

In the long run for Ulaanbaatar regulatory measures will not be sufficient regarding growing population as well as a growing motorisation rate and rebound effects: Greenhouse gases will not be reduced substantially and the problem of congestion and parking remains unsolved. There is additionally a partly low accessibility of housing areas, which calls for improvement of public transportation as a backbone. Additional to regulation direct impact on behaviour and transport demand is necessary to reduce the number of trips or conduct them with a sustainable mode: suitable is a policy mix of improvement of land-use planning together with investment in public transport and economic instruments. Mixes are necessary to take spatial and temporal effects of emissions into account (see different characteristics of the external costs of transport).

A policy mix with ambitious public transport improvement and regulation of car use is able to reduce car dependency and increase accessibility within a city and at the same time cuts back emissions and congestion (ITF 2017a, p.54). On the contrary sprawling cities enhance car dependency and require investment in transport infrastructure; the International Transport Forum judges this investment as not environmentally and financially sustainable especially in Asia and Latin America (ibid, p.54).

If the modal split is to be influenced towards a higher share of public transport the capacity of the currently existing system in Ulaanbaatar needs to be enlarged. As discussed provision and access to an affordable and sustainable transport system is a precondition for sustainable mode choice. For Ulaanbaatar there is a long history of planning activities to improve the public transport system which is currently based on a bus network. A city-wide Bus Rapid Transit Scheme (BRT) is planned as a backbone of Ulaanbaatar's public transportation system, which should provide an efficient, environmentally friendly as well as accessible and affordable mass transit system. This should especially connect satellite towns and traditional ger areas with predominantly lower income residents.

At present the BRT concept together with a traffic management system is part of an urban transport investment program (ADB 2018, p.3).

The general recommendations regarding the policy mix have to be adapted to the local conditions and in doing so knowledge can be gained from international best practice examples e.g. Mexico City, which has a similar geographic situation in which air pollutants air trapped over the city. From the mid-1980s onwards the city succeeded in cutting back pollution by comprehensive air quality management addressing private households and industry (Molina et al. 2009). Although air quality has substantially improved throughout the last thirty years the city still experiences regular problems. The air pollution mitigation strategies currently discussed as suitable policy mix ranges from state-of-the-art emission standards and mandatory vehicle inspection, differentiated economic instruments (taxes and incentives) to investment in sustainable modes and integrated land-use planning which involves tools such as a Mobility Master Plan (ITF 2017b).

CONCLUSION

In European and American agglomerations transport is a major source of pollution whereas high emission levels in Asian and African metropolitan areas are rather caused by the use of materials and fuels for heating and cooking. Nevertheless, with increasing economic wealth the motorisation rate grows continuously and leads to congestion and pollution (Baklanov et al., p. 245).

This analysis also holds for Ulaanbaatar, currently the focus is on air quality improvement by making domestic cooking and heating more efficient. There also is awareness regarding the necessity of directly influencing the external cost with improving the quality of fuel as well as the provision of an improved system of public transportation (see below), though there are also ideas which go beyond this improvement strategy. Approaches discussed also encompass improvement and enforcement of existing regulations (traffic laws, number plate restrictions) as well as pricing strategies (introduction of a congestion charge) a.o. (see Seaniger 2017). Regarding the growing demand of private motorised transport and related consequences in the long run strong focus is required on behaviour related instruments and a change in land-use planning backed up by infrastructure investments.

Planning the new BRT system and related improvement of the management capacity of the transport agencies is an important step towards more sustainable mobility. Up to now assistance for capacity development to improve the

ability of the urban transport agencies to plan and manage urban mobility in an integrated and sustainable way has been completed in 2018 (ADB 2018, p. 3). This approach was complemented with the recommendation to centralise transport planning and policy in one agency (ibid, p.4).

This potential reorganisation would also offer the opportunity to move towards an integrated planning approach to implement the above discussed long-term strategy. Currently there is only limited attention on the need for action to take care of a growing demand of private motorised transport and related consequences in the long run which would require behaviour related instruments together with a change in land-use planning.

An implementation requires a strategic planning framework for interlinking urban and transportation planning, preferably implemented by a specialised institution (Newman 2016). Whether a process towards sustainable urban mobility is started and how it is shaped is determined by the local agencies and needs to be based on the local frame conditions: a short term policy mix related to transport efficiency gains should be backed up by measures to influence modal split and transport demand.

Knowledge regarding barriers and challenges on the one hand and best practices or promising approaches on the other can be transferred. Especially regarding the suggested integrated planning approach barriers like overlapping responsibilities between different agencies or limited planning competences will have to be overcome. All authors nevertheless state that moving towards sustainability in transportation needs integration of various subjects as well as awareness and cooperation of all stakeholder groups.

REFERENCES

Amarsaikhan D., Battsengel V., Nergui B., Ganzorig M. and Bolor, G. (2014). A Study on Air Pollution in Ulaanbaatar City, Mongolia. Journal of Geoscience and Environment Protection, 2, pp. 123-128. doi: 10.4236/gep.2014.22017

Asian Development Bank ADB (2017). Proposed Policy-Based Loan Mongolia: Ulaanbaatar Air Quality Improvement Program. Concept Paper. [online] Available at: https://www.adb.org/sites/default/files/project-documents/51199/51199-001-cp-en.pdf [Accessed 26 Feb. 2019].

Asian Development Bank ADB (2018). Mongolia: Ulaanbaatar Urban Transport Capacity Development. Completion Report. [online] Available at: https://www.adb.org/projects/documents/mon-45140-001-tcr [Accessed 26 Feb. 2019].

Baklanov A., Molina L.T. and Gauss M. (2016). Megacities, air quality and climate. Atmospheric Environment, 126, pp. 235-249. doi: 10.1016/j.atmosenv.2015.11.059

Bertolini L., Curtis C. and Renne J.L. (2016). Introduction, In: Curtis C.. Renne J.L. and Bertolini L. (eds.). pp. 3-12.

Brenck A., Mitusch K. and Winter M. (2016). External Costs of Transport. In: Schwedes et al. (eds.). Handbook Transport Policy. 2nd ed. Wiesbaden, Springer, pp. 401-429 (in German).

Cervero R. (2003). Growing smart by linking transportation and land use: Perspectives from California. Builte environment, 29(1), pp. 66-78.

Curtis C., Renne J.L. and Bertolini L. (2016). Transit oriented development: making it happen. New York, Routledge.

Ewing R. and Cervero R. (2010). Travel and the Built Environment. A Meta-Analysis. Journal of the American Planning Association, 76(3), pp. 265-294. doi: 10.1080/01944361003766766

Falcocchio J.C. and Levinson H.S. (2015). Road Traffic Congestion: A Concise Guide, Springer Tracts on Transportation and Traffic 7. Cham, Springer Nature Switzerland.

German Environmental Agency (eds. 2018). Emissions of the Transport Sector (in German), [online] Available at: https://www.umweltbundesamt.de/daten/verkehr/emissionen-des-verkehrs#textpart-1 [Accessed 26 Feb. 2019].

Guttikunda S.K., Lodoysamba S., Bulgansaikhan B. and Dashdondog B. (2013). Particulate pollution in Ulaanbaatar, Mongolia. Air Quality, Atmosphere and Health, 6(3), pp. 589-601. doi: 10.1007/s11869-013-0198-7

High-level Advisory Group on Sustainable Transport (2016). Mobilizing Sustainable Transport for Development. Analysis and Policy Recommendations from the United Nations Secretary-General's High-Level Advisory Group on Sustainable Transport, [online] Available at: https://sustainabledevelopment.un.org/topics/sustainabletransport/highleveladvisorygroup [Accessed 26 Feb. 2019].

ITF (2017a). ITF Transport Outlook 2017. Paris, OECD Publishing.

ITF (2017b). Strategies for Mitigating Air Pollution in Mexico City, [online] Available at: https://www.itf-oecd.org/strategies-mitigating-air-pollution-mexico-city [Accessed 26 Feb. 2019].

Molina L.T., de Foy B., Vázquez Martínez O. and Páramo Figueroa V.H. (2009). Air Quality, Weather and Climate in Mexico City. World Metereological Organisation Bulletin, 58 (1), [online] Available at: https://public.wmo.int/en/bulletin/air-quality-weather-and-climate-mexico-city [Accessed 26 Feb. 2019].

Newman P. (2016). Planning for Transit Oriented Development: Strategic Principles. In: Curtis C., Renne J.L. and Bertolini L. (eds.). pp.12-22.

Ricardo-AEA (2014). Update of the Handbook on External Costs of Transport. Final Report. Report for the European Commission DG Move, [online] Available at: https://ec.europa.eu/transport/sites/transport/files/handbook_on_external_costs_of_transport_2014_0.pdf [Accessed 26 Feb. 2019].

Seaniger C.-A. (2017). 8-Step Solution to Solving Ulaanbaatar's Traffic Nightmare. The UB Post 25. Jan. 2017, [online] Available at: https://www.pressreader.com/mongolia/the-ub-post/20170125/281509340899617 [Accessed 14 June 2019].

Victoria Transport Policy Institute VTPI (2017). Rebound Effects. Implications for Transport Planning. TDM Encyclopedia, [online] Available at: http://www.vtpi.org/tdm/tdm64.htm [Accessed 26 Feb. 2019].

World Health Organisation WHO (2018). Air Pollution in Mongolia: Policy Brief, [online] Available at: http://www.wpro.who.int/mongolia/publications/20180228_policy_brief_on_air_pollution.pdf [Accessed 26 Feb. 2019].

Zhamsueva G.S., Zayakhanov A.S., Starikov A.V., Balzhanov T.S., Tsydypov V.V., Dementyeva A.L., Khodzher T.V., Golobokova L.P., Khuriganova O.I., Azzaya D. and Oyunchimeg D. (2018). Investigation of chemical Composition of Atmospheric Aerosol in Ulaanbaatar During 2005-2014. Geography and Natural Resources, 39(3), pp. 270-276. doi: 10.1134/S1875372818030113

Received on February 28th, 2019 Accepted on August 8th, 2019