

Southeast Asia-North and Central Asia transport corridors to support strengthening transport connectivity between the two subregions



TRANSPORT

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LIST OF ABBREVIATIONS

BP	British Petroleum
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GRP	Gross Regional Product
ESG	Environmental, Social, and Governance
FEU	Forty-Foot Equivalent Unit
GVA	Gross Value Added
IEA	International Energy Agency
IMF	International Monetary Fund
LLDC	Landlocked developing country
NCA	North and Central Asia
HS	Harmonised System
OECD	Organisation for Economic Co-operation and Development
SEA	Southeast Asia
TEU	Twenty-Foot Equivalent Unit
UN Comtrade	The United Nations Commodity Trade Statistics Database
UN SDG	The United Nations Sustainable Development Goals
UN WPP	The United Nations World Populations Prospects
WEO	World Economic Outlook

BACKGROUND

As highlighted in the recent policy documents and expert meetings of ESCAP, including the 2022 Regional Connectivity Forum on Connecting to Global Supply Chains and the Third Ministerial Conference on Regional Economic Cooperation and Integration (RECI), recent and current multiple connectivity shortages and disruptions, including those caused by the COVID-19 pandemic and the Ukraine crisis, pose a particular challenge to the landlocked developing countries in North and Central Asia (NCA).

One of their most significant implications is the heightened need to further diversify the subregion's transport and logistics links with other parts of Asia.

Given its rapid economic growth, which is expected to continue in the future, the subregion of South-East Asia (SEA) is of particularly strong interest to countries of North and Central Asia. The recent operationalization of Lao-China railway line is unifying rail network in the Association of Southeast Asian Nations (ASEAN) countries opening immense potential for commercially viable transport linkages with countries in North and Central Asia.

In August 2022, the Government of Kazakhstan requested ESCAP's assistance in studying the current and potential transport and logistics links between Central Asia and South-East Asia and exploring the opportunities for enhanced regional cooperation to explore the existing potential for greater inter-subregional trade.

In this context, ESCAP is implementing a technical cooperation activity focusing on building the capacity of the officials of transport and logistics ministries/agencies to facilitate inter-subregional transport connectivity between NCA and SEA. A capacity building workshop was organized in December 2022 to increase the understanding of the NCA and SEA policymakers on the current issues and available policy options for renewed regional cooperation on strengthening SEA/NCA transport linkages.

As part of the activity, ESCAP updated the information on NCA/SEA transport connections, including the infrastructure and operational connectivity along the Trans-Asian Railways linking the two sub- regions.

It has also identified the major persisting infrastructure missing links and operational bottlenecks along the key transport corridors and the opportunities generated by new technologies.

In doing so, the online interactive platform provided by the ESCAP portal on the regional Asia Pacific Transport Network (APTN) has been used to indicate NCA/SEA transport linkages.

A. SEA – NCA TRADE AND FREIGHT FLOWS

1. STATUS OF TRADE FLOWS AND ITS ANALYSIS FOR TWO SUBREGIONS

1.1. Key post-pandemic macroeconomic factors

COVID-19 impact on the economies, trade flows and transport links

In 2016-2019 active development of China – Europe inland trade resulted in important investments in transit transport infrastructure beneficial for all participating countries and primarily for landlocked developing countries in North and Central Asia which became important elements of transit trade. Since 2018 development of the first services connecting Southeast Asia with Europe by rail started.

These developments largely financed by Chinese and European sides (through both capital investments and operating subsidies) resulted in constant decrease of trade costs for developing countries in the region.

The COVID-19 pandemic broke this trend, instead new macroeconomic realities appeared:

1) Supply shock instead of demand. Usual economic recession leads to the decrease of credit financing volumes, fall in stock markets, and decline in demand. Due to suspension of production and border closures to prevent spread of pandemic, a supply shock was observed. Supply chains were broken at different stages, and interruptions or suspensions on the earlier stages impacted final production. The supply shock impacted demand.

2) Unknown and non-uniform measures of support, also for transport and logistics. The supply drop could not be overcome by usual anti-crisis measures of support from governments and national banks. There was no tested recipe for governmental position on the additional support to infrastructure or transport operators for this case, so each country applied different solutions, including countries located within the subregions.

3) Trade recovery was delayed by lack of uniform responses, including subregional ones. The spread of COVID-19 virus followed by asynchronous and non-uniform actions of countries for closure and opening negatively impacted on trade restoration.

Key transport connectivity-related macroeconomic impact of the COVID-19 for the Asian LLDCs is increase in transport costs with simultaneous decrease of resources to finance transport infrastructure enhancements.

Operations of border crossings during the pandemic only partially reflected trade and generally economic restrictions, as most of them were open for freight even amid the restrictions.

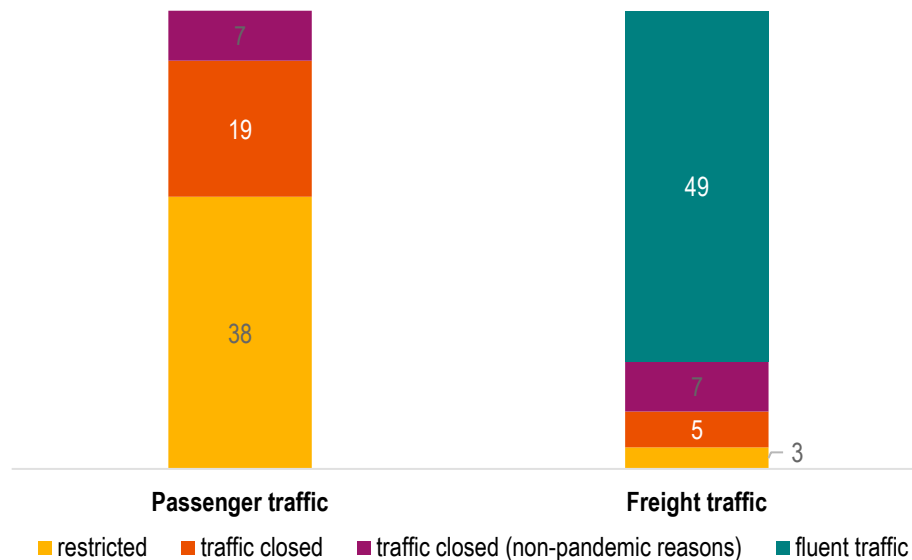
The situation caused by pandemic was characterized by differences in passenger and freight connectivity due to full or partial closures of national borders and border crossing procedures. As well as further challenges related to easing of border crossing restrictions or partial restrictions depending on the how the pandemic situation evolved in each country. This led to a high level of uncertainty regarding further changes, decreasing planning period for freight shippers and all other stakeholders.

Asynchronous actions by countries and significant differences in admission rules from country to country and additional health checks for personnel accompanying the cargo through the border crossings were among other challenges for transport connectivity significantly decreasing first and last mile connectivity.

Quarantine restrictions were partially hidden: while borders, terminals, seaports and other transport and logistics facilities for international trade in Asian subregions were mainly kept open, restriction referred

largely to business mobility and face-to-face communications – that discontinued or postponed integrative initiatives, mainly for new corridors.

Figure 1. Status of border crossings in ESCAP member countries¹ during the Pandemic



Total number of border crossings considered: 64 pairs
 Source: *Smart Railway Solutions, ESCAP, 2021.*

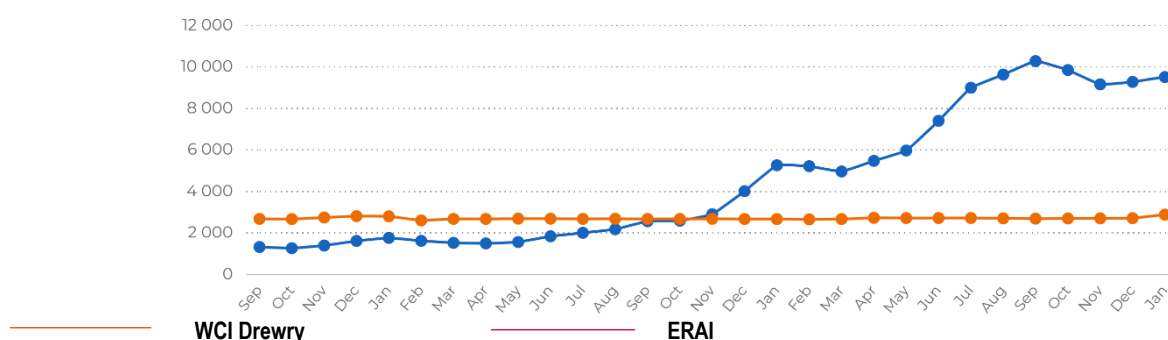
Logistics went from just-in-time to just-in-case deliveries. Because of the closure of end points of consumption, suppliers' warehouses were overcrowded as offline retailers were unable to pick up goods, importers could not find space to accommodate shipments that had not yet arrived by sea.

Lack of free empty equipment in Asian ports amid the increase in export volumes from Asia to Europe resulted in the increase in sea freight rates.

Shanghai Containerised Freight Index (SCFI) increased by 313 per cent from March 2020 to May 2021 and the same index for shipments to Europe increased from 1005 to 5212, that is 519 per cent during the same period. The China Containerised Freight Index (CCFI) rose from 889 to 1,810 during the same period. The World Container Index (WCI), calculated by Drewry, an international analytical agency, rose 326 per cent from 1,505 to 4,905. Rates peaked in January-February 2021, when there was maximum demand for shipping goods from Asia to Europe.

¹ As of September 15, 2020

Figure 2. WCI Drewry (maritime) and ERAI (rail) freight rates indices September 2019 – January 2022



Source: <http://index1520.com/en/>

All these factors led not only to continued growth of sea freight rates, but also to significant increase of shipping time. After the Suez accident, sea freight prices on several routes between ports in China and Europe rose to 8,000 US Dollars per FEU (forty-foot equivalent unit).

Together with a series of other events, the COVID-19 pandemic resulted in important decrease of the transport connectivity and limitation of the resources for its restoration and further development, especially for LLDCs. But in 2020-2021 the pandemic led rather to changes in trade volumes and costs, than to structural changes in traded commodities.

Impact of the Eurasian geopolitical crisis on the economies, trade flows and transport links

Eurasian geopolitical crisis against the background of the pandemic-related crisis and general cyclic economic slowdown resulted in further changing the global trade and transport.

Key macroeconomic and trade impact related to transport connectivity are structural changes in traded commodities due to sectoral sanctions imposed.

Table 1. Most impacted traded commodities in relation to NCA connectivity

GROUPS OF COMMODITIES	KEY CHANGES	IMPACT ON NCA COUNTRIES	SUBREGIONS WITH DEMAND FOR THE COMMODITIES
Oil and oil products	Restrictions to purchase oil and oil products from the Russian Federation.	Opportunities to increase exports from NCA countries, notably from Azerbaijan, Kazakhstan	EU, China, NCA (within the subregion)
Metals	Restrictions to purchase metals from the Russian Federation. Cessation of metal production and supplies from the Ukraine.	Opportunities to increase exports from NCA countries if economic complexity is increased.	EU, China, NCA (within the subregion), Southeast Asia (non-ferrous metals)

GROUPS OF COMMODITIES	KEY CHANGES	IMPACT ON NCA COUNTRIES	SUBREGIONS WITH DEMAND FOR THE COMMODITIES
Fertilizers	EU restrictions for bilateral trade with Russian Federation and Belarus.	Opportunities to partially substitute imports to the EU.	EU, Southeast Asia
Agricultural products and grains	Physical constraints for exports from the Ukraine.	Opportunities to increase exports to various subregions.	EU, Western Asia, South Asia, Southeast Asia, NCA (within the subregion)

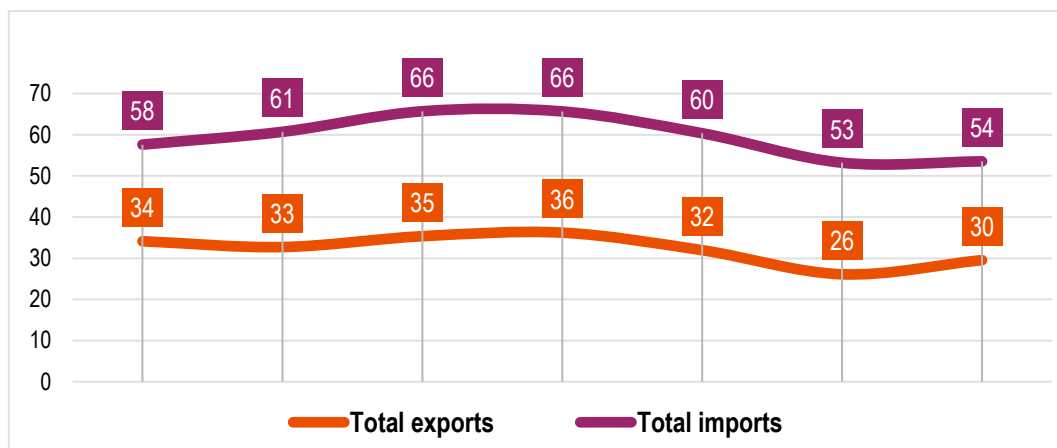
Source: authors' estimations based on United Nations Comtrade data

Conversion of geopolitical crisis into economic and trade consequences is a basis to estimate the possible impact on transport links: necessary capacities (from volumes of trade) and specific operational parameters such as transportation time, price, speed of border crossing procedures (from elasticities of the specific commodities).

1.2. Physical trade and freight flows analysis

Physical trade flows (in volumes) between SEA and North and Central Asia and EU have been decreasing since 2019, both exports and imports. But the share of *mainland Southeast Asian countries with access to inland Euro-Asian connections* grew in the overall structure of physical trade with NCA and the EU countries.

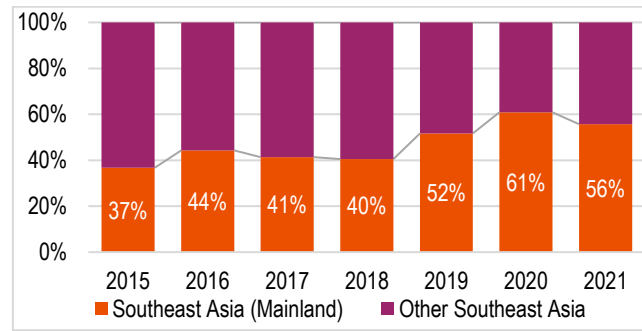
Figure 3. Total physical exports and imports dynamics (Southeast Asia with NCA + EU-27), thousand tonnes



Source: UN Comtrade

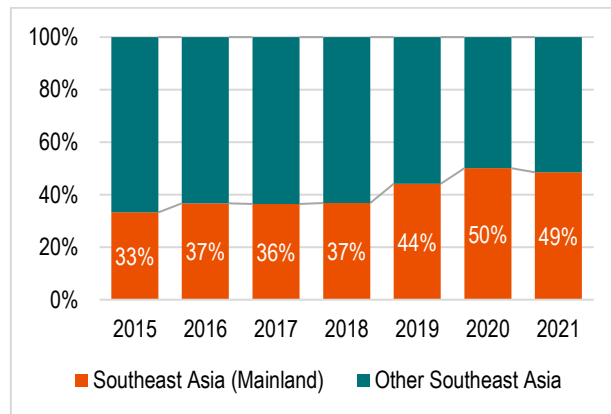
The role of developing Trans-Eurasian rail transport can be important for these dynamics, as the latest developments allow decreasing the share of transportation costs within the total cost of 1 ton of traded commodities.

Figure 4. Dynamic of imports structure from NCA + EU-27 to Southeast Asia



Source: UN Comtrade

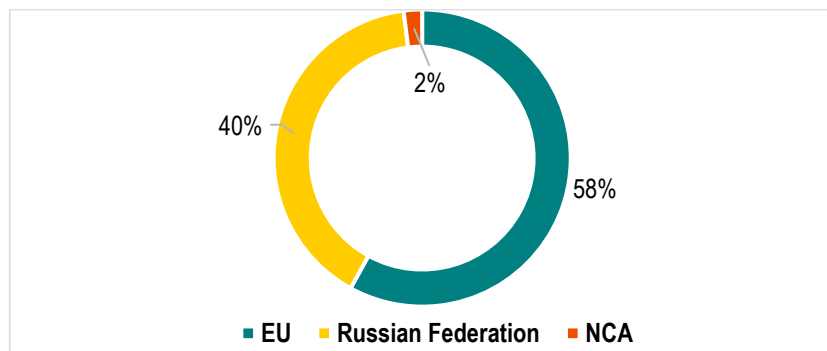
Figure 5. Dynamics of exports structure to Southeast Asia from NCA + EU-27



Source: UN Comtrade

In terms of directions of exports and imports, NCA countries (apart from the Russian Federation) are not key partners of SEA countries but considering important role of NCA countries in inland transit (more than 80 percent of Asia – Europe – Asia transit rail traffic passed through Kazakhstan in 2018-2022), better connectivity of NCA and SEA countries may help in increasing SEA – EU inland freight flows.

Figure 6. Share of subregions in international trade of SEA countries



Source: UN Comtrade

In terms of traded commodities, agricultural products and fertilizers should be emphasized in relation to global food security, and metals and articles thereof in terms of general importance for economic growth of SEA countries.

Table 2. Physical trade flows (SEA – NCA) by types of commodities

EXPORTS BY GROUPS OF COMMODITIES	SHARE	IMPORTS BY GROUPS OF COMMODITIES	SHARE
Agricultural products (excl. Grains)	35%	Coal and coke	36%
Chemical products, plastics, rubber	24%	Oil and oil products	16%
Ferrous and non-ferrous metals and articles thereof	8%	Agricultural products (excl. Grains)	9%
Grains	7%	Wood, pulp and paperboard	8%
Machinery, equipment and transport	6%	Fertilizers	7%
Ores, stones, earths, etc.	6%	Chemical products, plastics, rubber	7%
Textile, leather, etc.	5%	Ferrous and non-ferrous metals and articles thereof	6%
Oil and oil products	5%	Grains	5%
Other	2%	Ores, stones, earths, etc.	4%
Wood, pulp and paperboard	1%	Machinery, equipment and transport	2%
Fertilizers	<1%	Textile, leather, etc.	1%
Coal and coke	<1%	Other	<1%

Source: UN Comtrade (direct statistics of SEA countries)

2. TRADE PROJECTIONS INDICATING FREIGHT FLOWS

2.1. Macroeconomic trends and trade forecasts for key commodities

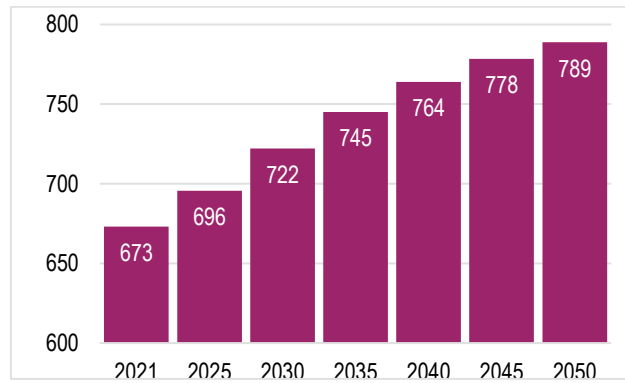
Despite the fact that current trade flows between NCA and SEA are moderate, macroeconomic trends suggest possible increase for specific groups of commodities.

Key trends are as follows:

- 1) Important forecasted population growth in SEA countries – linked with consumption of agricultural products and fertilizers.
- 2) Higher than average forecasted GDP growth in SEA countries – linked with production and imports of steel (metal ores, metals).
- 3) Increase in complexity of NCA economies ensuring, if happened, growth of production of metals and articles thereof, as well as agricultural production intensity.

According to United Nations World Population Prospects (medium scenario), the population in SEA countries will grow 1.2 times till 2040 with a positive dynamic till 2062.

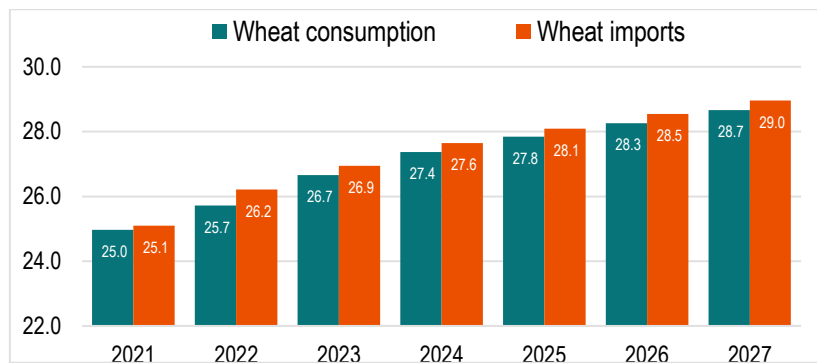
Figure 7. Population growth projections in SEA countries, million people



Source: UN WPP

Population growth is one of the key factors defining the future demand for agricultural products, including grains, and more specifically wheat.

Figure 8. Wheat consumption and import projections in selected SEA countries, million tonnes

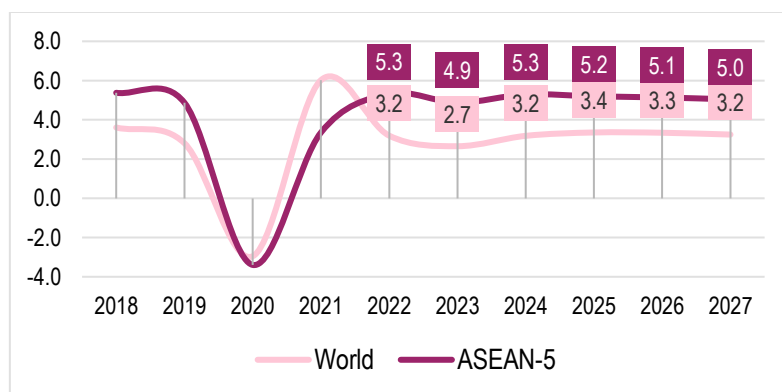


Source: OECD-FAO, *Agricultural Outlook (2022)* * Southeast Asia – sums of Indonesia, Malaysia, Philippines, Thailand, Viet Nam

Southeast Asia is one of the subregions driving global population growth. Lack of wheat production forms a high base for growth of wheat imports to the region (+3.9 million tonnes) in the medium term, while NCA countries, and notably Kazakhstan, has an opportunity to increase wheat production and wheat exports.

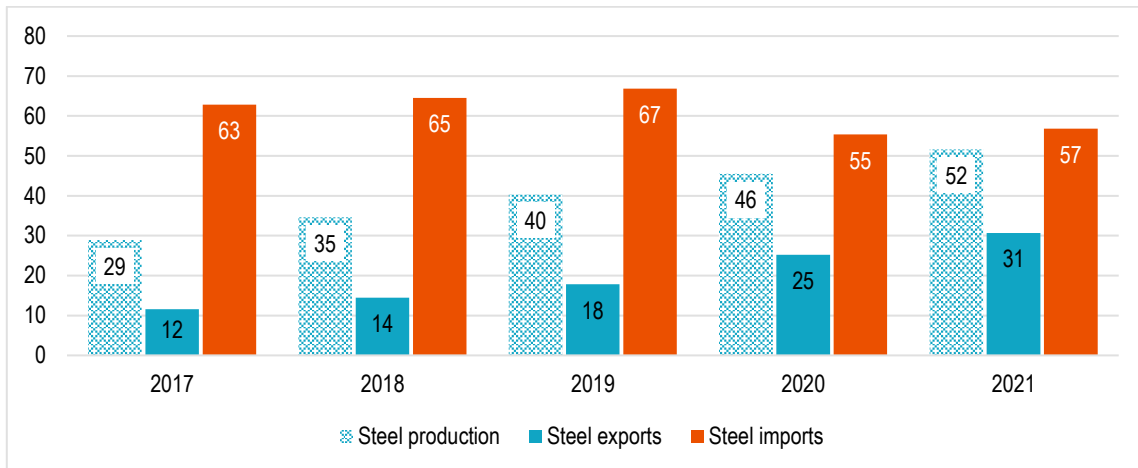
GDP dynamics in SEA countries refers to higher growth than global average. This is a key factor defining the future demand for steel, ferrous metals and ferrous ores.

Figure 9. GDP growth projections, constant prices, % change



Source: IMF WEO (October 2022)

Figure 10. Steel production and trade structure in Southeast Asia*, million tonnes



Source: World steel association

*Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam

Despite the growth of steel production in Viet Nam, the total demand in the market remains significant, while NCA countries may develop metal production through complexity increase against the background of destroyed metallurgy in the Ukraine and sanctions on the Russia's metal exports.

Macroeconomic trends refer to positive conditions for further growth of bilateral NCA – SEA trade, the demand being created mainly on the Southeastern side, though efforts in enhancing both connectivity and economic complexity are necessary to achieve important trade volumes.

If no improvements in connectivity are considered, trade forecasts refer to the flowing figures by groups of commodities. Detailed methodology for trade forecasts is provided in [Annex 1](#).

Table 3. SEA exports to NCA LLDCs, 1000 tonnes (bottom – top)

COMMODITY GROUPS	2021	2022	2023	2024	2025	2026	2027
Agricultural products (excl. Grains)	74.9	87.8	88.6 – 97.1	91.0 – 111.0	90.9 – 123.0	91.6 – 132	94.6 – 140.0
Chemical products, plastics, rubber	18.4	19.3	18.8 – 20.2	19.3 – 22.6	19.1 – 24.4	19.0 – 24.5	19.0 - 24.4
Machinery, equipment, transport	5.9	6.2	6.3 – 6.8	6.3 – 7.2	6.3 – 7.7	6.3 – 8.1	6.4 – 8.4
Grains	5.2	5.3	5.3 – 5.8	5.4 – 6.4	5.4 – 7.0	5.5 – 7.2	5.5 – 7.4
Textile, leather, etc.	3.3	3.7	3.7 – 4.0	3.7 – 4.4	3.8 – 4.8	3.8 – 5.2	3.9 – 5.7
Total exports	113.0	127.0	128.0 – 140.0	131.0 – 158.0	131.0 – 174.0	131.0 – 185.0	134 – 195.0

Source: authors' estimations, only mainland SEA countries with direct inland connections are considered

Table 4. SEA imports from NCA LLDCs, 1000 tonnes (bottom – top)

COMMODITY GROUPS	2021	2022	2023	2024	2025	2026	2027
Fertilizers	45.9	50.0	50.4 – 61.0	51.3 – 74.6	52.3 – 91.8	53.3 – 113	54.4 – 138
Ferrous, non-ferrous metals	34.8	39.3	40.0 – 42.8	41.2 – 47.4	42.4 – 52.6	43.9 – 61.2	45.1 – 70.5
Grains	11.7	12.3	12.6 – 17.3	12.9 – 33.3	13.1 – 49.3	13.4 – 65.3	13.5 – 81.3
Chemical products, plastics, rubber	6.2	6.8	6.9 – 8.3	7.0 – 10.2	7.1 – 12.5	7.3 – 15.4	7.4 – 18.9
Textile, leather, etc.	5.6	6.1	6.2 – 6.7	6.2 – 7.3	6.3 – 8.0	6.4 – 8.7	6.4 – 9.5
Total imports	106.0	116.0	118.0 – 138.0	120.0 – 175.0	123.0 – 217.0	126.0 – 266.0	129.0 – 322.0

Source: authors' estimations, only mainland SEA countries with direct inland connections are considered

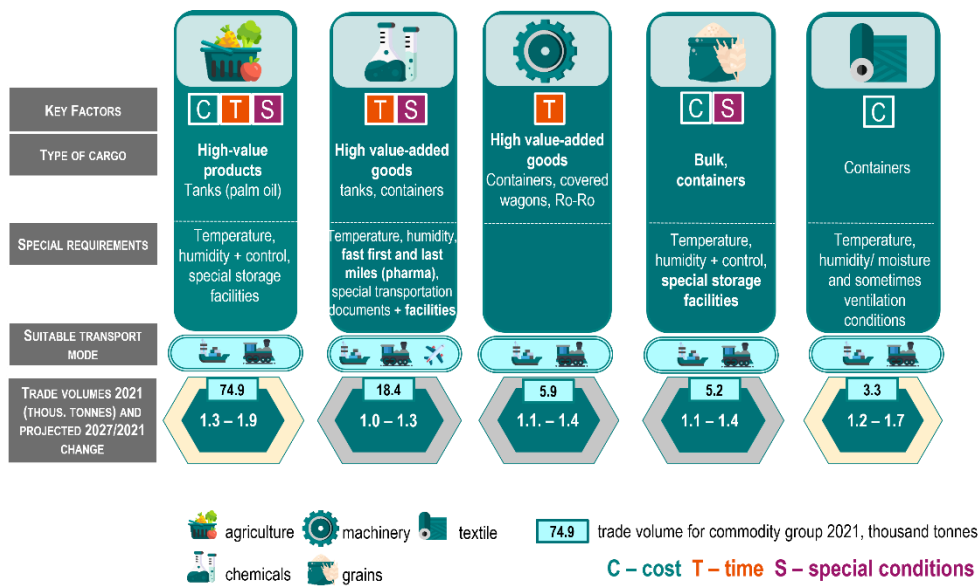
SEA – NCA LLDCs bilateral trade projections are moderate in physical terms. These projections considered current allocation of freight flows by transportation modes, where almost 99 per cent of cargo goes by sea, and **no changes in total transportation costs** (transportation price + cost of time + transport reliability costs).

2.2. From trade to transport requirements: inter-regional economic and transport connectivity profiles

Inter-regional economic and transport connectivity profile refers to the description of retrospective (actual) and future trade between two or several subregions or countries (but not one country/subregion to all other subregions) by types of commodities in relation to transport requirements. This may also be applied in case a specific group of commodities with further allocation by subgroups is analyzed.

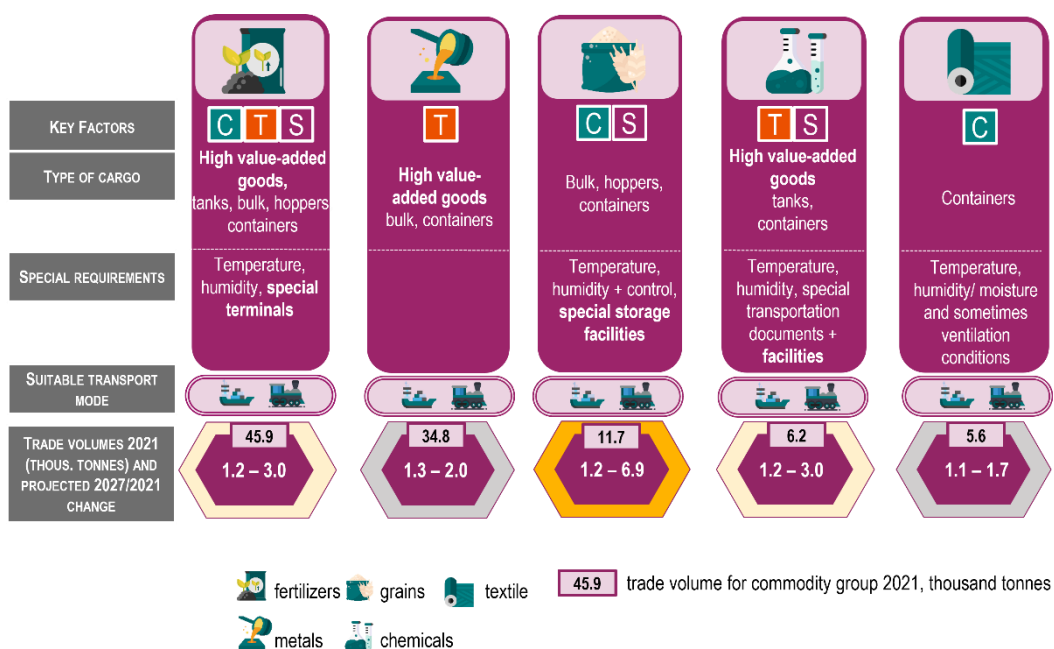
Inter-regional connectivity profile allows a *first-stage transport links and transport mix planning and primary estimations of opportunities to shift specific cargo from one transport mode to another* or to propose multimodal solutions.

Figure 11. SEA – NCA inter-regional economic and transport connectivity profile



Source: authors' estimations based on trade data

Figure 12. NCA - SEA inter-regional economic and transport connectivity profile



Source: authors' estimations based on trade data

Economic and transport connectivity profile shows the following:

- most types of cargo can be transported by both maritime and inland modes, that gives a basis for **at least partial modal shift, especially for high value-added goods** that prevail in bilateral trade,
- most types of traded commodities are sensitive not only to total transportation costs, but also to specific transportation of storage conditions – **that emphasized the role of (a) transport reliability, (b) availability of specific facilities for these commodities, while just general rail or road infrastructure would not be sufficient to ensure any modal shifts,**
- all key traded commodities can be containerized, which is a positive fact for both long-distance Trans-Eurasian and generally multimodal transportation resulting in costs and time decrease and **possible freight flows induction thanks to overall trade costs decrease.**

Rough estimations on possible freight flows shift and induction will be provided in Part B.

B. SEA – NCA TRANSPORT LINKAGES AND OPPORTUNITIES TO FOSTER CONNECTIVITY

3. CURRENT TRANSPORT LINKAGES AMONG TWO SUBREGIONS, ON-GOING PROJECTS, AND EXISTING INITIATIVES

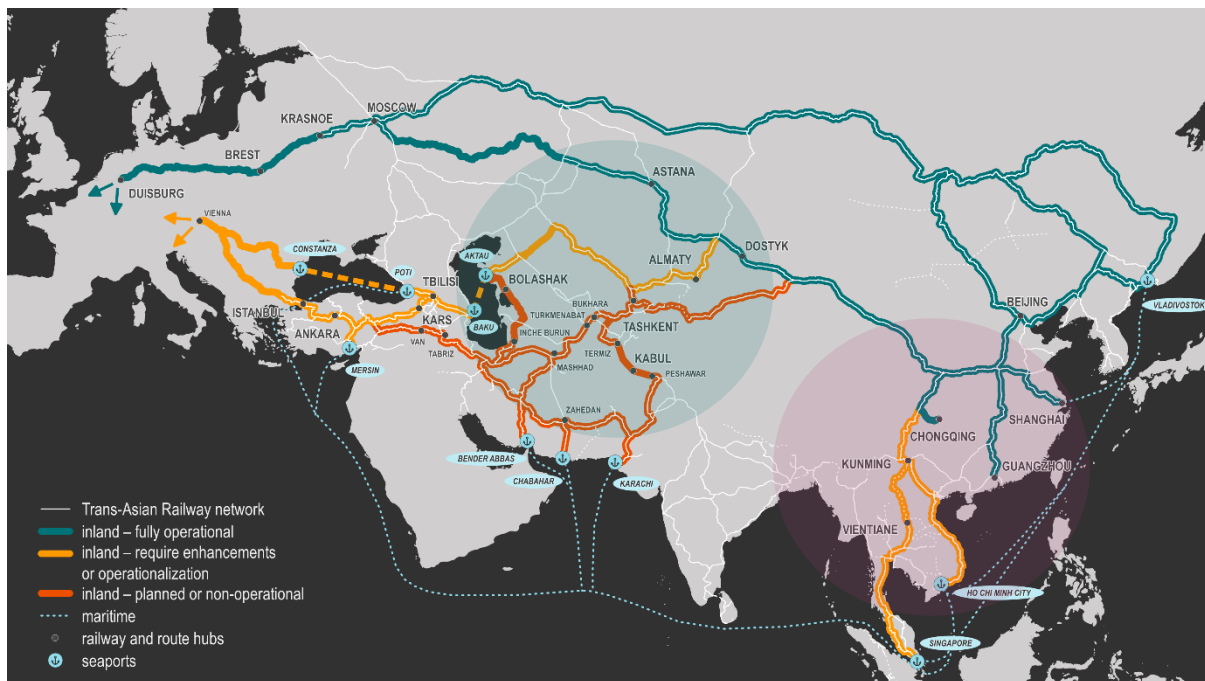
3.1. Existing and planned routes

Considering landlocked position of most countries in North and Central Asia, all existing transport links refer to either inland transportation or to multimodal routes with rail-to-sea or road-to-sea connections.

Existing transport links are, on the one hand, multi-optional, but, on the other hand, currently limited in operations:

- there is **only one fully operational** corridor that does not require capacity enhancements, but it has restrictions related to economic sanctions,
- **most transport links are not yet fully operational** both in terms of available capacities and “soft” operational connectivity (interoperability, one-window for shippers, facilitation of cross-border operations),
- all transport corridors **with maritime links are not yet fully operational**,
- all inland corridors are by now considered for East – West or North – South transit with China in Eastern Asia and India in South Asia being main countries of origin or destination, while connections to Southeast Asia **are still under construction and/ or have operational constraints**.

Figure 13. Scheme of international transport corridors connecting NCA and SEA



Source: compiled by authors based on data from APTN

ESCAP portal on the regional Asia Pacific Transport Network (APTN)

APTN is an interactive platform that displays maps of the current extension of Asian Highways, Trans-Asian Railways, and international dry ports, together with selected operational information for major routes along these networks. It also includes selected information on the maritime ports.

The goal of APTN is to facilitate data collection and sharing from the different countries, as well as to support the process of considerations of the updates of upgrades and extensions to regional transport network. APTN may also serve as a basis for the monitoring and the development of international transport corridors.

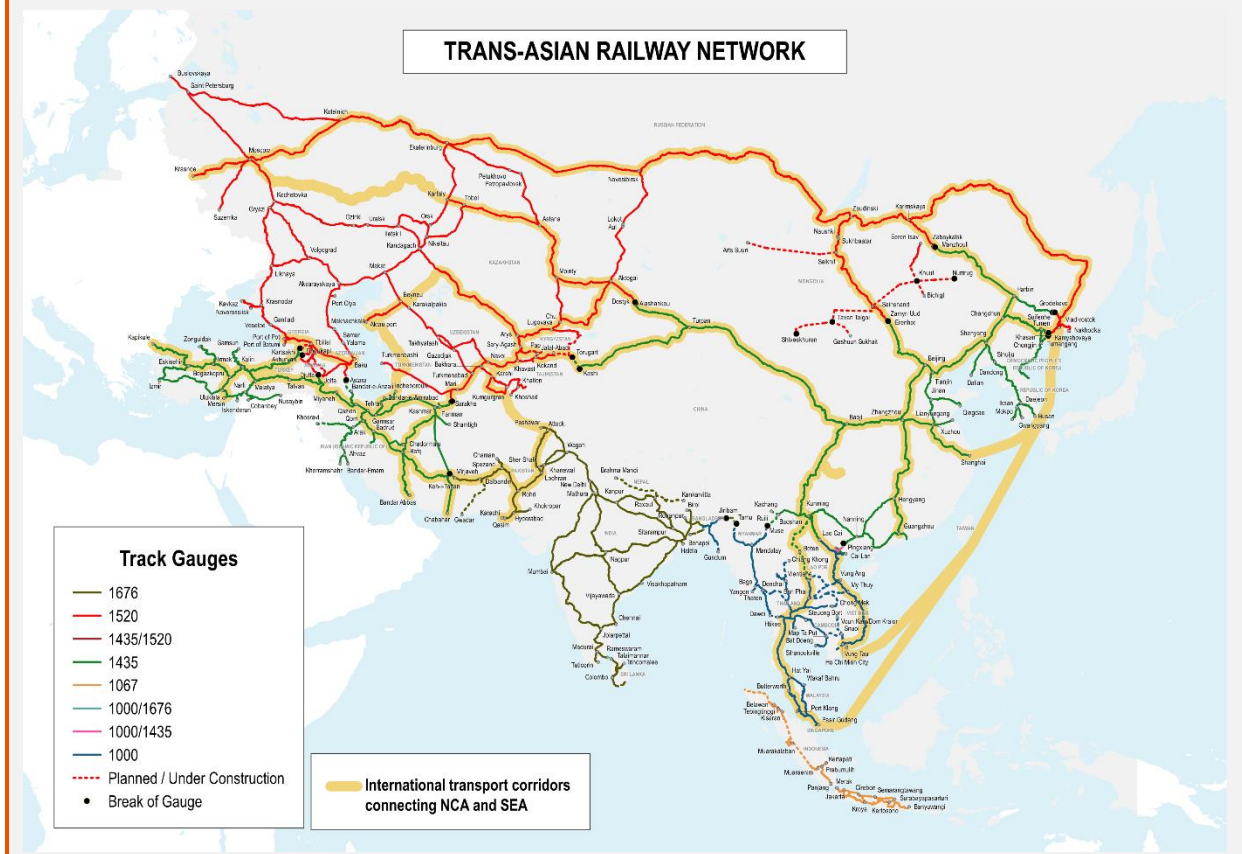


















Table 5. Key functioning and planned *inland* transport corridors connecting NCA with other subregions in Asia

CORRIDOR		DESCRIPTION AND OPPORTUNITIES FOR SPECIFIC COMMODITIES	CURRENT STATUS	CHALLENGES	LINKS WITH ASIAN SUBREGIONS
1. China – Kazakhstan – Russian Federation – Belarus - EU		Key route for EU – China links	Fully operational , one-window facility (more than 80 per cent of China – EU rail transit in 2021)	Geopolitical trade restrictions and sanctions	Southeast Asia 
2. Trans-Caspian route (TITR, Middle Corridor, TMTM)		Second best option to deliver Chinese goods and Kazakhstan's exports to the EU	Fully operational , but requires capacity expansions (less than 5 per cent of China – EU rail transit in 2021)	Multimodality (ferry), 4 countries of transit	Southeast Asia 
3. China – Kazakhstan – Uzbekistan – I.R.Iran – Türkiye – EU (Southern corridor)	 	Linking the EU and China through countries with the largest populations, including I.R.Iran and Türkiye	Limited operations	Numerous bottlenecks along the entire route, 5 countries of transit	Southeast Asia 
4. (Russian Federation) - Kazakhstan – Turkmenistan – I.R.Iran (Bendarabbas) (KTI)		Access to I.R.Iran and to the sea links, mainly for agricultural products, oil and oil products, metals	Limited operations	Unsettled tariff policy with Turkmenistan, I.R.Iran and Turkmenistan, rail infrastructure gaps	South Asia Southeast Asia 
5. Kazakhstan – Uzbekistan – I. R. Iran (Chah Bahar)		Access to Indian Ocean ports for high value-added goods (metals) with comparatively lower infrastructure costs	Partially operational , further development required	Need for intergovernmental agreements, development of logistics centers, expansion of Iranian ports	South Asia Southeast Asia 
6. Kazakhstan (Aktau) – I.R.Iran Bandarabbas					
7. China – Kyrgyzstan – Uzbekistan		Linking the EU and China NCA	Planned	Numerous border crossings, mountainous terrains (extra traction)	Southeast Asia 
8. Kazakhstan – Uzbekistan – Pakistan		Access to Indian Ocean ports for oil, ore, coal, agricultural goods and metals.	Planned	Passage through 4 countries. High capital intensity (no railway in Afghanistan)	South Asia Southeast Asia 

Source: compiled by authors based on data from APTN

3.2. On-going and planned projects, initiatives, and activities

Most transport connectivity enhancement projects carried out in NCA, Southeast Asia and other subregions in 2020-2022 can be classified as follows: (1) new construction and capacity enhancement, (2) new services (operations).

Table 6. New connectivity projects in NCA and other Asian subregions in 2020-2022

No	REGION	COUNTRY	TYPES OF PROJECTS		IMPACT ON CONNECTIVITY (EI – EXPORT AND IMPORT LINKS FOR LLDC, T – TRANSIT VIA LLDC)
			(1) NEW CONSTRUCTION AND CAPACITY ENHANCEMENT	(2) NEW SERVICES (OPERATIONS)	
1	NCA	Azerbaijan	2020 - work to rebuild a disused railway which would allow <i>north-south</i> trains to bypass the Baku conurbation started		T
2				2021- twice-weekly container block train service from Baku to Mersin and Istanbul launched	T
3				2021 - Azerbaijan Caspian Shipping Co's new Caspian Sea train ferry Azerbaijan entered service, linking Baku with Kuryk in Kazakhstan and Turkmenbashi in Turkmenistan	T
4		Kazakhstan	2021 - works to double-track and electrify the line from the Alakol area to Dostyk on the Chinese border started		EI
5		Uzbekistan	2020 - electrification of the 331 km railway ring in the Ferghana Valley officially completed		EI
6				2021 – special tea trains (for tea and tea products) launched between China and Uzbekistan	EI
7				2022 – a new intermodal service from Japan to Uzbekistan via China and Kazakhstan launched	EI, T
8	Southeast Asia	Lao People's Democratic Republic	2021 - the 418 km railway linking Vientiane and the Chinese border at Boten formally opened for revenue services		EI, T
9				2022 - The Vientiane South freight transshipment yard opened	EI, T
10				2022 - Nippon Express Co (China) launched a multimodal freight service using rail between Kunming in China and Vientiane in Laos, and then lorry from Vientiane to Thailand and other ASEAN countries	EI, T
11		Myanmar		2021 - first trial shipment completed on a sea, road and rail freight corridor linking Chengdu with the Indian Ocean via Myanmar (the route is intended to provide inland China	T

No	REGION	COUNTRY	TYPES OF PROJECTS		IMPACT ON CONNECTIVITY (EI – EXPORT AND IMPORT LINKS FOR LLDC, T – TRANSIT VIA LLDC)
			(1) NEW CONSTRUCTION AND CAPACITY ENHANCEMENT	(2) NEW SERVICES (OPERATIONS)	
	Viet Nam			with a route to and from southeast Asia which avoids China's eastern ports)	
12				2021 – Trains launched from Yen Vien bound for Zhenzhou in China and then Liège in Belgium to carry containers of textiles, leather and footwear	T
13				2022 – direct maritime link from Viet Nam (Ho Chi Minh) to the Russian Federation (Vladivostok) launched, it is supposed to collect cargo from Thailand, Malaysia, India and Pakistan	T
14	South Asia	Afghanistan		2020 – first I.R.Iran to Afghanistan freight train launched	EI
15				2021 - line from Aqina on the Turkmen border to the northern town of Andkhoy in Afghanistan inaugurated	EI
16				2021 - shipment of Chinese commercial and transit goods delivered to the commercial port of Hairatan by rail from Urumqi via <i>Uzbekistan</i>	EI, T
17	South Asia	Bangladesh		2021 - Oxygen Express train services (medical equipment) launched by Indian Railways	EI
18				2021 - regular freight services on the cross-border line between Haldibari in India and Chilahati in Bangladesh restarted after a hiatus of 56 years	EI
19	South Asia	I.R.Iran	2021 - agreement to complete the 30 km Shalamcheh – Basra railway which would connect the national rail networks of I.R.Iran and Iraq signed		EI, T
20			2021 – an MoU for the construction of the rail link between Esfahan and Ahvaz signed		T
21	Western Asia	Türkiye		2020 - first rail service from Xi'an in China to Izmit via Khorgos, the Caspian Sea ports of Aktau and Baku, and the Baku – Tbilisi – Kars railway with a transit time of 18 days launched	T
22				2020 - the Samsun – Kalin section of the line from the Black Sea city of Samsun to Sivas in central	

No	REGION	COUNTRY	TYPES OF PROJECTS		IMPACT ON CONNECTIVITY (E – EXPORT AND IMPORT LINKS FOR LLDC, T – TRANSIT VIA LLDC)
			(1) NEW CONSTRUCTION AND CAPACITY ENHANCEMENT	(2) NEW SERVICES (OPERATIONS)	
			Anatolia was reopened for freight operations		
23				2021 – the first container train carrying household appliances from Türkiye to Russia by rail via the Baku – Tbilisi – Kars corridor	T
24				2021 - a partnership to develop rail freight between Europe and Azerbaijan, Kazakhstan, Uzbekistan and China via the Köseköy Terminal to the east of Istanbul formed by Austrian and Turkish companies	T
25			2021 - Kars logistics centre, created to serve the Baku – Tbilisi – Kars railway officially opened		T
26			2021 - electric services launched over the entire 352 km length of the Ankara – Kayseri main line		T
			(1) CARRIED OUT WITHIN LANDLOCKED DEVELOPING COUNTRIES		
			(2) CARRIED OUT IN OTHER COUNTRIES		

Source: compiled by authors based on publicly available information in sectoral media and at the official websites of transport companies and transport authorities

It should be noted that for landlocked countries transport connectivity enhancing projects in the transit countries may have a high importance for both allowing exports and imports thanks to the links with maritime segments and unlocking transit potential.

In 2020-2022 most of the enhancements referred to in the inclusion of LLDCs in East – West – East Eurasian connections, in which the priority were the connections (a) to the existing trunk lines with largest volumes of transportation and highest number of services and (b) to transit countries with highest levels of transport services. This refers to the choice of **economically optimal connections** allowing cheaper inclusion to the Eurasian transport flows and faster results.

In the meantime, in the same period announcements of completely new connections and developments were made supposing changes in the transport landscape and the position of LLDCs. This opens a new stage of transport connectivity **shift from optimality to alternativity and generally higher resilience**.

The announced planned activities related to further transport connectivity enhancement in NCA, SEA and other Asian subregions refer primarily to the following:

- strategic planning of new inland connections to seaports of South Asia for NCA countries
- diversification of transit and export-import routes through NCA countries with focus on the specific commodities most impacting on the economic growth of LLDC
- improvement of “soft” connectivity via adoption of common regional standards and interoperability

- further development of missing along the existing transportation backbone – both in NCA and in Southeast Asia.

All announced plans require important capital investments, and some of the projects, especially those in NCA LLDCs, are already backed by the international development institutions.

Table 7. Announced connectivity enhancements and strategic projects in NCA, Southeast Asia for the period 2022-2030 and until 2050

No	REGION	COUNTRY			POSSIBLE IMPACT ON ASIAN LINKS AND CONNECTIONS WITH LLDCs
			(1) NEW CONSTRUCTION AND CAPACITY ENHANCEMENT	(2) NEW SERVICES (OPERATIONS)	
1	NCA	Azerbaijan	throughput capacity of Baku International Sea Trade Port to be increased to 25 million tonnes by 2040		Close of capacity gaps for Kazakhstan's, Uzbekistan's exports and China – EU container transit
2		Kazakhstan		EBRD to promote development of the Middle Corridor, including fleet production (ferries, containers), reorganisation of transit freight operations	Close of capacity gaps for Kazakhstan's exports and China – EU container transit
3				restarting of rail export of crude oil from Kazakhstan westwards is being considered by key producers	Boosting Kazakhstan's exports and economic growth largely linked to oil exports
4		Tajikistan	construction of Tajikistan – Afghanistan – Turkmenistan railway by 2030 (CAREC Transport Strategy)		Inclusion of Tajikistan into rail network
5		Turkmenistan		Turkmenistan is to join OSJD agreements on International Transit Tariffs and Uniform Transit Tariffs with the aim of boosting China – Europe traffic	Increase in regional interoperability
6		Uzbekistan	Bukhara – Miskin – Urgench – Khiva electrification by 2030 (CAREC Transport Strategy)		General enhancements and improvement of the sustainability
7			Electrification of Pap – Namangan – Andijon railway by 2030 (CAREC Transport Strategy)		
8			construction of electrified Angren – Pap line (completed 2016), with electrification of Pap – Kokand – Andijan line by 2030 (CAREC Transport Strategy)		

No	REGION	COUNTRY			POSSIBLE IMPACT ON ASIAN LINKS AND CONNECTIONS WITH LLDCs
			(1) NEW CONSTRUCTION AND CAPACITY ENHANCEMENT	(2) NEW SERVICES (OPERATIONS)	
9		Uzbekistan, Kyrgyzstan	railways of <i>Afghanistan</i> , Uzbekistan, Kyrgyzstan and China agreed to trial a rail and road 'economic corridor' linking the four countries		NCA to South Asia direct link with an option to connected with SEA via China
10			construction of China – Kyrgyzstan – Uzbekistan railway by 2030 (CAREC Transport Strategy)		
11	Eastern Asia	Mongolia	construction of a new line in southern Mongolia by 2030 (CAREC Transport Strategy)		Improvement of connectivity in Eastern Asia
12	Southeast Asia	Thailand	department of Rail Transport announced plans to develop an international rail freight terminal and transshipment facility on the border with Laos to handle traffic on the future line from China		Inclusion of Lao People's Democratic Republic into transit links
13		Viet Nam	plans to be drawn up for nine new railway lines totalling 2 362 km by 2050, including connection of the port of Vŭng Áng to the border with Lao People's Democratic Republic		Unlocking Lao People's Democratic Republic and its inclusion into maritime transit links with South Asia, NCA and other regions
14	South Asia	Afghanistan	construction of a Mazar-i-Sharif – Herat – Kandahar– Quetta railway line by 2030 (CAREC Transport Strategy)		Construction of infrastructure for further regional network allowing LLDC's access to the seaports
15			a new railway line is proposed as a joint initiative by Uzbekistan, Afghanistan and Pakistan to give access for NCA LLDCs to the seaports		
16		I.R.Iran	construction of a Astara – Rasht missing link considered to complete the development of Western North – South corridor connecting Russian Federation with the Ports of the Indian ocean		Increase in capacities along KTI route thanks to shift of some volumes to the Western part of North – South corridor (mainly exports of the Russian Federation)
			(1) CARRIED OUT WITHIN LANDLOCKED DEVELOPING COUNTRIES		
			(2) CARRIED OUT IN OTHER COUNTRIES		

Source: compiled by authors based on publicly available information in sectoral media and at the official websites of transport companies and transport authorities

3.3. Challenges for NCA – SEA connectivity

The following challenges for NCA – SEA connectivity may be emphasized based on the analysis of (1) the inter-regional economic and transport connectivity profile, (2) trade projections, (3) current links, (4) announced and on-going enhancing activities:

- NCA – SEA connections are currently not considered within dedicated comprehensive program resulting in development of **economic cooperation corridor(s)**.
- Inland transport enhancements are **not targeted at decreasing trade costs for specific commodities**.
- There is **no long-term economic and transport project planning and prioritizing system** for the corridors.
- For each existing route and corridors under construction there is **a set of hard and soft constraints requiring international solutions**.

4. IDENTIFICATION OF TRANSPORT CORRIDORS WITH HIGH POTENTIAL TO FOSTER STRONG TRANSPORT LINKAGES

4.1. Estimations for possible shift to rail and induced trade flows

Comprehensive combined macroeconomic and transport modelling is required to get exact estimation for possible shift to rail and induced trade flows for each route, each connection and each commodity.

This analysis proposes only rough estimations based on the following prerequisites:

- 1) United Nations Conference on Trade and Development data on percentage of transport costs within the value per tonne of commodity² (data as of 2016),
- 2) the World Bank's estimations on transportation costs reduction **thanks to construction of Lao People's Democratic Republic to China link**,
- 3) trade forecasts as provided above.






Lao People's Democratic Republic to China link

Construction of Lao People's Democratic Republic to China link (the Boten-Vientiane railway) is an important milestone in ensuring SEA overland connectivity with other Asian regions and European countries being a part of the Belt and Road Initiative.

This new link has a specifically important impact on the mutual connectivity of the landlocked developing countries in SEA and NCA, forming a direct connection line and providing opportunities to extend existing Eurasian corridors to SEA countries.

According to the World Bank's estimations, with complementary policies in place, the railway could lower land transport costs by 1/3 and attract traffic that is currently using maritime routes. These assumptions are considered below to assess opportunities to induce trade flows between SEA and NCA.






Table 8. Opportunities to shift freight flows to railways and to induce NCA exports to SEA

COMMODITY GROUPS	2021	VALUE, US DOLLARS PER 1 TON	% OF TRANSPORT COSTS	RAIL ENHANCEMENTS*	2027 NO CHANGE	2027 – INDUCED FROM RAIL, 1000 TONS (FROM COSTS ONLY)
 Fertilizers	45.9	416	20.5%	14%	54.4 – 138	+248.3
 Ferrous, non-ferrous metals	34.8	1,728	40.3%	27%	45.1 – 70.5	+42.8
 Grains	11.7	386	21.9%	15%	13.5 – 81.3	+46.8
 Chemical products, plastics, rubber	6.2	1,913	20.5%	14%	7.4 – 18.9	+40.6
 Textile, leather, etc.	5.6	2,799	69.1%	46%	6.4 – 9.5	+6.8

Additional 385.3 thousand tonnes may be induced from rail enhancements for key commodity groups under present conditions, these flows could go by rail.

² Share of transportation costs in the total cost of one tonne of a product depends (1) on the value chain of the specific commodities within aggregated commodity groups, (2) on the costs of transportation for the specific export links.

Table 9. Opportunities to shift freight flows to railways and to induce SEA exports to NCA

COMMODITY GROUPS	2021	VALUE, US DOLLARS PER 1 TON	% OF TRANSPORT COSTS	RAIL ENHANCEMENTS*	2027 NO CHANGE	2027 – INDUCED FROM RAIL, 1000 TONS (FROM COSTS ONLY)
 Agricultural products (excl. Grains)	74.9	1,578	19.6%	13%	94.6 – 140	+46.3
 Chemical products, plastics, rubber	18.4	3,458	24.1%	16%	19.0 - 24.4	+12.1
 Machinery, equipment, transport	5.9	80,513	27.8%	19%	6.4 – 8.4	+3.1
 Grains	5.2	535	19.6%	13%	5.5 – 7.4	+0.7
 Textile, leather, etc.	3.3	2,367	34.3%	23%	3.9 – 5.7	+0.7

Additional 62.9 thousand tonnes may be induced from rail enhancements (Lao People’s Democratic Republic – China links) for key commodity groups under present conditions, these flows could go by rail.






Costs of time and reliability may increase the induced volumes by 2.5 depending on the commodity group. The cost of time is calculated based on the unit cost of goods, transportation time and credit rate and reflects the “frozen assets”, or the costs of commodities not being used within commercial value chains during transportation period. Costs of time are higher for high-value added goods. The reliability costs depend on the unit cost of the goods, the standard deviation of the time of transportation of goods for the specific connection and the credit rate. Less reliable routes, which is often the case for less standardized overland transportation against maritime transportation, and especially for the routes with many borders, may be inappropriate for some added value chains, while increase in reliability may shift additional flows to more reliable routes.

Unlike SEA – NCA – SEA exports, it appears that SEA – EU trade induced by new rail link is also possible for time sensitive goods but it needs much granular data on existing freight flows and infrastructure. Currently maritime transportation costs are 1/3 to 1/2 lower than rail costs.

Shift to railways is possible under two options:

- 1) substantial improvement in rail performance resulting in time savings and decrease in time-related costs,
- 2) more supportive policies promoting shift to rail for more sustainable freight transport and harmonizing rules on inland transportation of dangerous goods (notably through China).

Table 10. Opportunities to shift freight flows to railways and to induce exports from SEA to EU

COMMODITY GROUPS (SEA TO EU)	2021	VALUE, US DOLLARS PER 1 TON	% OF TRANSPORT COSTS - RAIL	RAIL ENHANCEMENTS*	% OF TRANSPORT COSTS - SEA
 Agricultural products (excl. Grains)	2,418.1	1,691	33.4%	22.2%	8.2%
 Chemical products, plastics, rubber	1,998.3	6,082	17.5%	11.7%	5.7%
 Wood, pulp, paper, cellulose	2,081.5	621	28.8%	19.2%	8.9%
 Fertilizers	1,009.7	420	17.5%	11.7%	12.4%
 Metals	870.9	3,302	51.6%	34.4%	5.9%

Rough estimations of possible shift to inland transport show opportunities not just to derive freight flows from sea to rail, but to induce trade thanks to rail development. These estimations do not consider capacities or improvement of operations along existing routes, apart from new Lao People's Democratic Republic to China connection. Consideration of all other factors may result in more important figures.

4.2. Identification of transport corridors with high potential referring to economic and transport connectivity profiles

The following transport corridors are either functional or semi-functional. They may be considered as priority links to ensure NCA – SEA trade, as well as SEA – EU transit via NCA countries.

TRANS-CASPIAN INTERNATIONAL TRANSPORT ROUTE (TITR, MIDDLE CORRIDOR)

Type of transportation: multimodal.

Commodities: Delivery from NCA of oil products, fertilizers, agricultural goods, metal products with high added value imports to Central Asian countries and transit of containerized goods.

Prospects and opportunities:

- multiple increase in transportation volumes due to switching from the northern route in the short term, followed by stagnation,
- prioritization of the route by European freight market participants.

Challenges:

- lack of development strategy,
- lack of a unified and interconnected system of operational management,
- lack of a "one-stop shop" system for users and, consequently, a competitive loss to the Northern Route,
- lack of rigid coordination and linkage of multimodal transport solutions, including their possible interchangeability,
- significant infrastructure constraints,
- significant underestimation of traffic volumes and development plans for these volumes.

KAZAKHSTAN – TURKMENISTAN – I. R. IRAN (KTI)

Type of transportation: railway

Transport from NCA of grain and metals to South and Southeast Asia with rail-sea links.

Commodities: Oil, grains and agricultural products.

Prospects and opportunities:

- significant increase in the volume of transportation by sending Kazakhstan's oil, other export goods for export by sea in the direction of Southeast Asia, Africa,
- prioritization of the route by Russian cargo market participants.

Problems

- lack of a unified and interconnected operational management system,
- insufficient transparency of the business system for customers.

(SOUTHEAST ASIA) – CHINA – KAZAKHSTAN – UZBEKISTAN – I. R. IRAN – TÜRKIYE (SOUTHERN ROUTE)

Type of transportation: railway

Commodities: Transit of containerized goods, delivery of commodities to/from SEA countries with possible link to Western Asia.

Prospects and opportunities:

- increase of transportation volumes due to switching from the northern route,
- prioritization by the European participants of the freight market.

Problems:

- lack of a unified and interconnected operational management system,
- uncoordinated tariff policy of railway administrations (Kazakhstan, Uzbekistan).

4.3. Key factors impacting on smooth transportation and its role in inducing international trade for NCA and SEA regions

The restructuring of the global and the Eurasian trade links brings out new requirements for fast, relatively cheap, and resilient transportation that can help to construct new supply chains. **This emphasizes a particular role of railways and rail-based international corridors, as** it is faster (than sea), cheaper (than air), and is suitable for longer distances (than trucks).

And it is here where the issues of cross-border procedures, digitalization, interoperability, and digital interoperability (e-interoperability) become important factors of the success of the railways.

Border crossing is one of the most important elements of international railway connectivity. Over the past years national authorities and railway companies have intensified their efforts to assure faster procedures not only by increasing the capacity of infrastructure, but also by removing existing so called soft constraints.

Key issues to consider are:

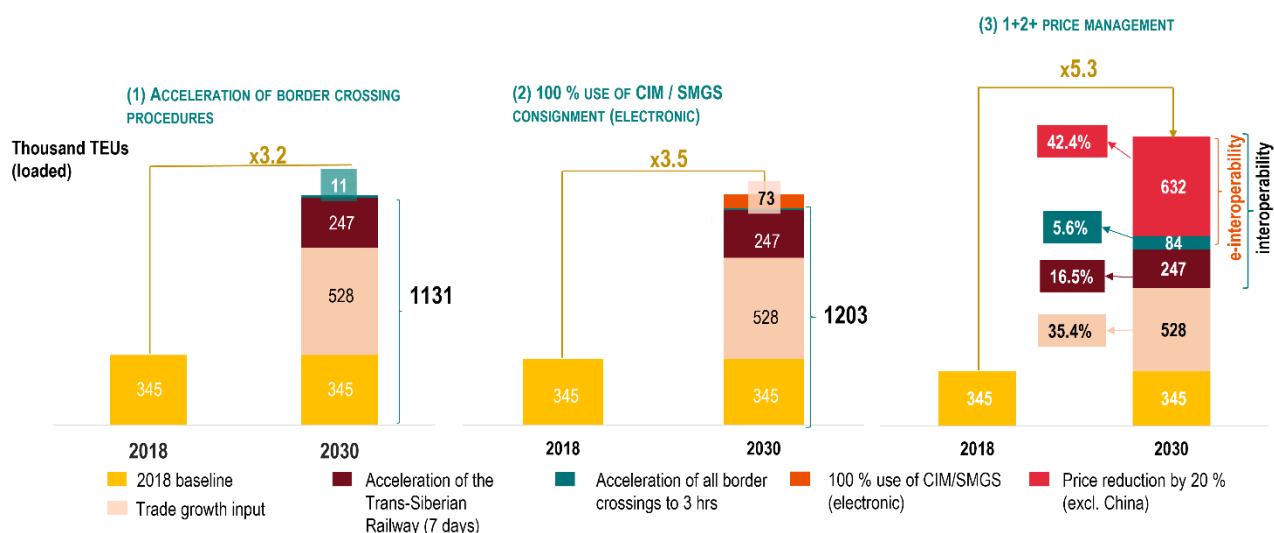
- customs – railways interaction interfaces,
- pre-arrival information,
- electronic data exchange among stakeholders,
- simplified customs and control formalities,
- non-intrusive checks for normal clearances,
- move from documents to e-data and creation of digital ecosystems with distributed data.

Interoperability of existing infrastructure refers to ‘soft’ arrangements requiring intensive international collaboration. This refers to harmonization of procedures in different countries along international corridors to result, once again, in faster border crossing and general acceleration and decrease in costs of transportation. **Common consignment note**, also in a digital form, should be noted as a must for uninterrupted and fast international operations. In North and Central Asia interoperability, infrastructural and operational, is partially considered within the programmes of the Eurasian Economic Commission

(which do not cover all countries of the region), while approaches, rules and regulations for the Southeast Asia in this regard are yet to be developed, also with involvement of ASEAN secretariat.

E-interoperability might be the most interesting set of solutions that impacts directly on international transportation and at the same time does not require any changes in national systems and is more about the form, than about the content. But it requires strong international cooperation and important institutional work at the national level.

Figure 14. Estimation of interoperability and e-interoperability input to Euro-Asian rail freight transit traffic under “the best rail case” option



Source: Eurasian corridors: development potential, UIC, 2020. TSR refers to Trans-Siberian Railway TEU – twenty-foot equivalent unit

As international studies prove that **improvement of cross-border procedures, interoperability, digitalization, and digital interoperability** may have a direct and important impact on the induced **volumes of trade**, these opportunities are to be further studied for each specific route and pairs of countries.

5. POLICY RECOMMENDATIONS

1. Establishment of current and future economic and transport connectivity profiles for subregions

Objectives: to ensure higher accuracy of transport infrastructure and connectivity planning considering limited resources.

Recommended actions:

- 1) To consider in-depth analysis, forecast and modelling of trade flows.
- 2) To analyze optimal transportation parameters for each traded commodity to understand optimal transport profiles for each route.
- 3) To model the sufficiency of existing plans, top and bottom requirements.
- 4) To agree on the future backbone transport connectivity links.

2. Elaboration of a prioritizing methodology and mechanism for transport connectivity projects

Objectives: to ensure coherent transport connectivity planning.

Recommended actions:

1) To develop Trans-Asian connectivity projects prioritizing methodology based on (a) national, (b) subregional and (c) Asian wider economic effects from connectivity projects – in partnership with international development institutions.

The prioritizing methodology refers to agreeing on common principles of the choice of connectivity enhancements for international corridors to accelerate their commercialization and operationalization, as well as to ensure maximum positive effects for the economies of Asian LLDCs.

For example, at national level the prioritizing methodology could refer to multi-criteria analysis as referring to the World Bank's Infrastructure Prioritization Framework³ (IPF). It is a tool for prioritizing infrastructure projects based on financial, economic, social and environmental indicators, which are combined into two indices - socio-environmental (SEI) and financial-economic (FEI) - and considers them along with public budget constraints for a particular sector. Specific parameters to calculate SEI and FEI are to be defined considering specific needs.

Projects are prioritized on a quadrant basis:

A. Projects with the highest priority, as they are effective from both socio-economic and financial points of view (the project is effective for both the state and the population, as well as for business).

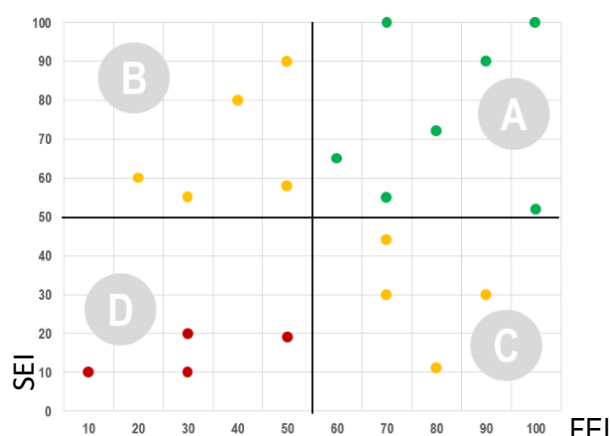
B. Projects that are more effective from a socio-economic point of view for the state and the population, e.g. improve the connectivity of the countries of the regions and/or comply with the ESG agenda. However, such projects may require additional budget support, as indirect effects may prevail over direct effects.

C. Projects that are more financially efficient, e.g. have a quick return on investment, are highly profitable and do not require significant government support. Such projects may have a smaller radius of impact on the economy and population, but have larger direct effects.

D. Projects that require additional research at this stage of appraisal and prioritization to refine the parameters and possible effects *OR requalification at stage 2*, as they may have a high corridor importance.

³ <https://thedocs.worldbank.org/en/doc/844631461874662700-0100022016/original/160423InfrastructurePrioritizationFrameworkFinalVersion.pdf>

Figure 15. Classification of connectivity projects



The next stage – subregional refers to qualitative analysis and simple sum up. Maximum meaning is 5, but it requires national assessment first. The exact criteria are to be determined and tested.

Table 11. Possible criteria and assessment options at subregional/ international level

No	Criteria	Options	Attributed value
1.	Does this project contribute to the achievement of the United Nations SDGs, higher environmental and social sustainability?	1) projects classified A and B at national assessment stage 2) projects not classified A and B, but having a specifically high importance (confirmed in national strategic or other documents) 3) other options	1) 1 2) 0.5 3) 0
2.	Is this project a part of the Trans-Asian backbone rail network?	1) yes, a missing link 2) yes, upgrade/ enhancement of existing infrastructure 3) no	1) 1 2) 0.5 3) 0
3.	Is this project a part of the subregion's international transport corridors?	1) yes, it ensures direct connections between capitals or economic centers/ development of hubs in the capitals or centers 2) yes, this is a border crossing infrastructure 3) yes, but it does not ensure direct connections between capitals or economic centers development of hubs in the capitals or centers, neither is it a border crossing infrastructure 4) no	1) 1 2) 0.5 3) 0.3 4) 0
4.	Is this project a part of a larger economic/ social project?	1) yes, it comes together with the development of special economic zones, areas, public spaces or cities, production areas 2) this is a part of a multimodal transport project/ border crossing enhancement project 3) no, it is a standalone rail project	1) 1 2) 0.5 3) 0
5.	Is the project financially efficient?	1) projects classified A and C at Stage 1 2) projects with guaranteed funding 3) other options	1) 1 2) 0.5 3) 0

Source: compiled by authors

2) To agree on the certification of projects and to establish relevant centres to facilitate financing of transport connectivity projects - in partnership with international development institutions.

Certification procedure may refer to (1) confirmation of project priority, (2) breakdown by type of possible funding.

Such certification can be discussed with development banks and institutions, as well as national and subregional funds to confirm the priority of projects together with the recommendations on financing forms.

3. Corridor-based harmonization

Objectives: to ensure successful performance of existing rail, road, and multimodal corridors by continuing harmonization projects within the regions, not limited to existing subregional organizations.

Recommended actions:

- 1) To work on the multilateral agreements on the functioning of the system of commodity flows and infrastructure projects to ensure subregion-to-subregion connectivity.
- 2) To launch LLDC-related transport corridors monitoring programme to regularly assess the efficiency of developments and operations, economic role sufficiency and to be used as an element for projects certifying.
- 3) To continue improvements of border crossing procedures – also based on recommendations on previous ESCAP studies, including enhancement of seamless data interchange and electronic interoperability.

4. Development of “guaranteed transportation” programmes for LLDCs for specific commodities

Objectives: to secure exports of key traded commodities for LLDC (primarily agriculture and food, other goods to be defined).

Recommended actions:

- 1) To define specific commodities that are crucial for LLDCs’ economies with special focus on food security (in collaboration with UNCTAD, FAO) and match with the priorities for transport connectivity in Asia.
- 2) To elaborate dedicated “guaranteed transportation” programme, combining technical, guarantees for priority transit via third countries, accelerated cross-border procedures and other transportation options.
- 3) To annually assess the effects from the programmes.

ANNEX 1. TRADE FORECASTING METHODOLOGY

APPLIED APPROACH

Gravity models.

Gravity models refer to **factor regression (econometric) models** that allow explaining trade patterns in connection with changes in other macroeconomic indicators.

The general calculation formula is as follows:

$$\ln E_{js} = \alpha_0 + \alpha_1 \ln GDP_j + \alpha_2 \ln GDP_s + \alpha_3 \ln T_{js} \dots + \alpha_n \ln x_n + e_{js}$$

where

E_{js} – export of commodities from region j to region s,

GRP_j – GDP or GRP of the j-th exporting territory,

GDP_s – GDP of the s-th importing territory,

T_{js} – distance indicator (geographical, temporal or cost) between regions,

$x_4 \dots x_n$ – other influencing factors (if necessary),

$\alpha_1 \dots \alpha_n$ – elasticity coefficients showing the influence of factors on E_{js} ,

e_{js} – random errors.

TRADE MATRICES BETWEEN COUNTRIES

For each product group, a gravity model of the form (1) is estimated:

$$\ln E_{ijt} = \alpha + \alpha \ln S_{it} + \beta \ln D_{jt} - \gamma \ln d_{ijt} + z_{ijt} \quad (1)$$

where

E_{ijt} – physical exports from the i-th territory (country or region of the country) to the j-th territory in the t-th year,

S_{it} – supply factor of the i-th territory in the t-th year,

D_{jt} – demand factor of the j-th territory in the t-th year,

d_{ijt} – total transportation costs for delivery from the i-th territory to the j-th territory in the t-th year,

α, β, γ – elasticity of exports from supply factors, demand factors and total transportation costs,

z_{ijt} – other factors, including prices, exchange rates, factors of inertia, etc.

To estimate the coefficients of the model (1) one can use the method of least squares, the method of instrumental variables, etc. The level of HS codes used is 4 digits.

The international trade database UN Comtrade and national data sources are used as input data for modelling. If exports and imports of parts of a country are to be modelled, national customs data on physical volumes (in kg) of exports and imports in annual trends over a period of at least 5 years are used. .

Instead of the most commonly used factors in gravity models (GDP and population), the proposed methodology selects *sector-specific supply and demand factors for each commodity group* whenever possible.

The selection of supply and demand factors for the international trade model (1) is based on the following criteria:

- availability of unified, international sources of information for all countries of the world,
- availability of the medium and long term factor projections,
- statistically significant influence of factors on the modelled trade indicators.

Table A1. Demand and supply factors for international trade

No	COMMODITY GROUP	DEMAND FACTORS	SUPPLY FACTORS
1.	Animal and vegetable products	<ul style="list-style-type: none"> • Population size • Imports of agricultural production 	<ul style="list-style-type: none"> • Agricultural food production
2.	Cereals	<ul style="list-style-type: none"> • Population size • Imports of cereals 	<ul style="list-style-type: none"> • Cereals production
3.	Prepared foodstuffs	<ul style="list-style-type: none"> • Population size • Imports of sugar • Imports of agricultural products 	<ul style="list-style-type: none"> • Sugar production • Agricultural food production
4.	Construction Materials	<ul style="list-style-type: none"> • Investments in fixed capital 	<ul style="list-style-type: none"> • Industry GVA
5.	Ferrous metal ores	<ul style="list-style-type: none"> • GDP • Steel production 	<ul style="list-style-type: none"> • Iron ore mining
6.	Non-ferrous ores	<ul style="list-style-type: none"> • GDP • Industry GVA 	<ul style="list-style-type: none"> •
7.	Coal	<ul style="list-style-type: none"> • Coal consumption • GDP • Industry GVA • Steel production 	<ul style="list-style-type: none"> • Coal mining
8.	Coal coke	<ul style="list-style-type: none"> • Coal coke consumption • GDP • Steel production 	<ul style="list-style-type: none"> • Coke production
9.	Gas	<ul style="list-style-type: none"> • Gas consumption • GDP • Industry GVA 	<ul style="list-style-type: none"> • Natural gas extraction
10.	Oil and oil products	<ul style="list-style-type: none"> • Oil and oil products consumption • GDP • Industry GVA 	<ul style="list-style-type: none"> • Oil extraction
11.	Chemical products	<ul style="list-style-type: none"> • Manufacturing GVA • GDP 	<ul style="list-style-type: none"> • Manufacturing GVA • GDP
12.	Fertilizers	<ul style="list-style-type: none"> • Grain production • Fertilizers consumption 	<ul style="list-style-type: none"> • Fertilizers production

No	COMMODITY GROUP	DEMAND FACTORS	SUPPLY FACTORS
13.	Plastics and rubbers	<ul style="list-style-type: none"> • Manufacturing GVA • GDP 	<ul style="list-style-type: none"> • Manufacturing GVA • GDP
14.	Wood and wood products	<ul style="list-style-type: none"> • Investments in fixed capital • GDP 	<ul style="list-style-type: none"> • Roundwood and lumber production
15.	Pulp and paper products	<ul style="list-style-type: none"> • Investments in fixed capital • GDP 	<ul style="list-style-type: none"> • Pulp and paper production
16.	Light industry products	<ul style="list-style-type: none"> • Population size • GDP 	<ul style="list-style-type: none"> • Cotton production
17.	Ferrous metals	<ul style="list-style-type: none"> • GDP • Steel and steel products consumption • Manufacturing GVA 	<ul style="list-style-type: none"> • Steel production
18.	Non-ferrous metals	<ul style="list-style-type: none"> • GDP • Manufacturing GVA 	<ul style="list-style-type: none"> •
19.	Metals and articles thereof	<ul style="list-style-type: none"> • GDP • Manufacturing GVA 	<ul style="list-style-type: none"> • Steel production
20.	Machinery and equipment	<ul style="list-style-type: none"> • GDP • Manufacturing GVA • Investments in fixed capital 	<ul style="list-style-type: none"> • GDP • Manufacturing GVA
21.	Vehicles	<ul style="list-style-type: none"> • GDP • Manufacturing GVA • Investments in fixed capital 	<ul style="list-style-type: none"> • GDP • Manufacturing GVA
22.	Other products	<ul style="list-style-type: none"> • Population size • GDP 	<ul style="list-style-type: none"> • GDP

The main scenario forecasts for these factors are taken from the following sources.

Table A2. Forecasting sources for gravity model factors by countries and subregions of the world

No	INDEX	FORECAST SOURCE
1.	GDP	IMF-WEO, OECD
2.	Investments in fixed capita;	IMF-WEO
3.	Population size	UN
4.	Coal mining	IEA, BP
5.	Gas extraction	IEA, BP
6.	Oil extraction and oil products production	IEA, BP
7.	Coal consumption	IEA, BP, calculation results of the commodity balance model for coal developed by InfraEconomy Group
8.	Gas consumption	IEA, BP
9.	Oil and oil products consumption	IEA, BP, calculation results of the commodity balance model for oil and oil products developed by InfraEconomy Group (Error! Reference source not found.)

No	INDEX	FORECAST SOURCE
10.	Production of agricultural foodstuffs	OECD-FAO
11.	Grain production	OECD-FAO, results of calculations of the commodity balance model for grain developed by InfraEconomy Group
12.	Production of finished food products	OECD-FAO
13.	Fertilizer production	FAO, IFA, results of the fertilisers commodity balance model developed by InfraEconomy Group
14.	Production of roundwood and lumber	FAO
15.	Pulp and paper production	FAO
16.	Cotton production	OECD-FAO
17.	Import of agricultural food products	OECD-FAO
18.	Grain imports	OECD-FAO, results of the grain commodity balance model, developed by InfraEconomy Group
19.	Import of finished food products	OECD-FAO
20.	Fertilizer consumption	FAO, IFA, InfraEconomy Group
21.	Production steel of the importing country	OECD
22.	Steel consumption	World Steel Association, results of the ferrous metals commodity balance model developed by InfraEconomy Group