

A Global Value Chain Analysis of China's Virtual Water Footprint Through Agricultural Trade

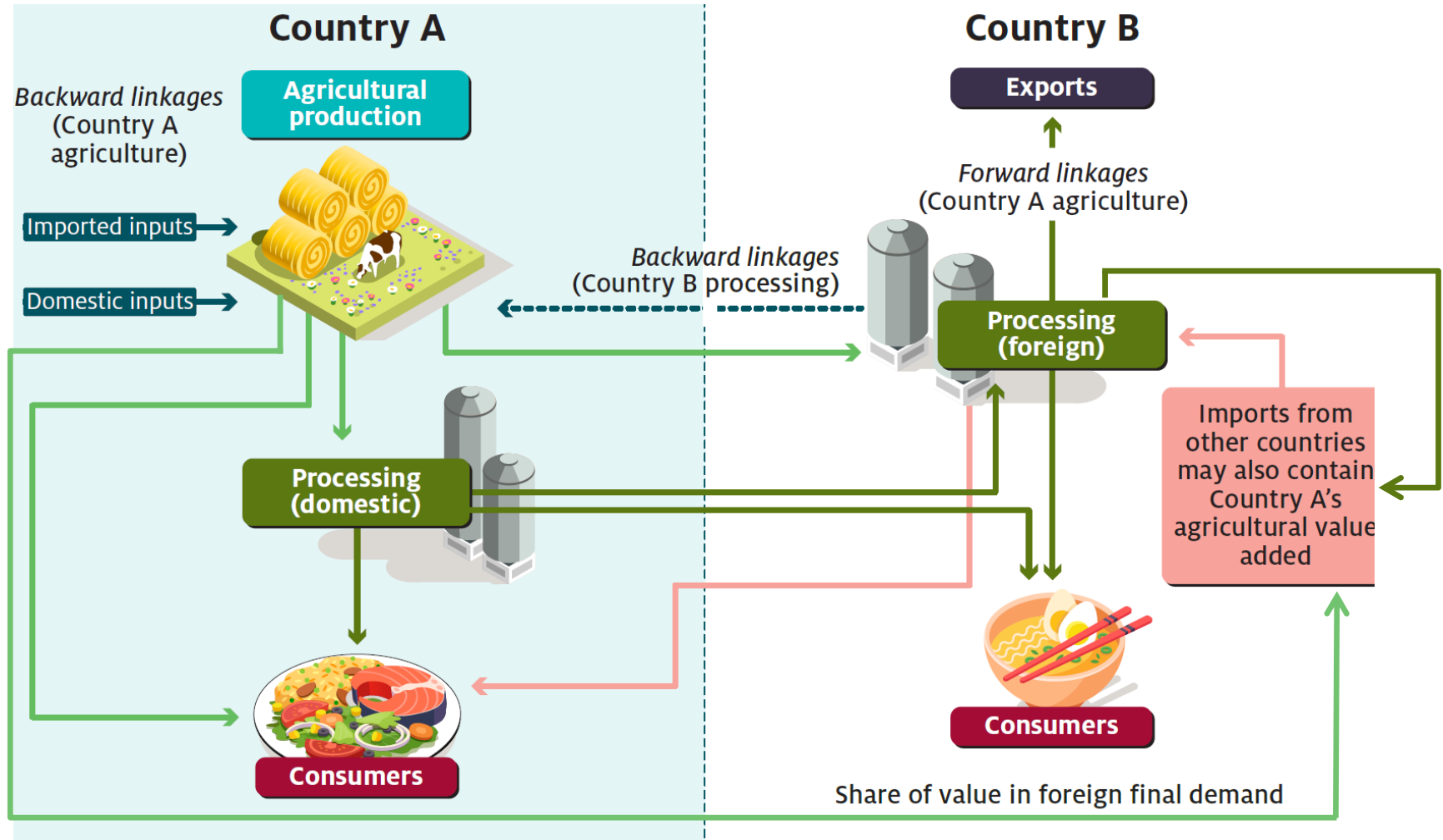
Tariq Ali^{*,1}, Wei Xie², Anfeng Zhu¹

¹ North China University of Technology, Beijing

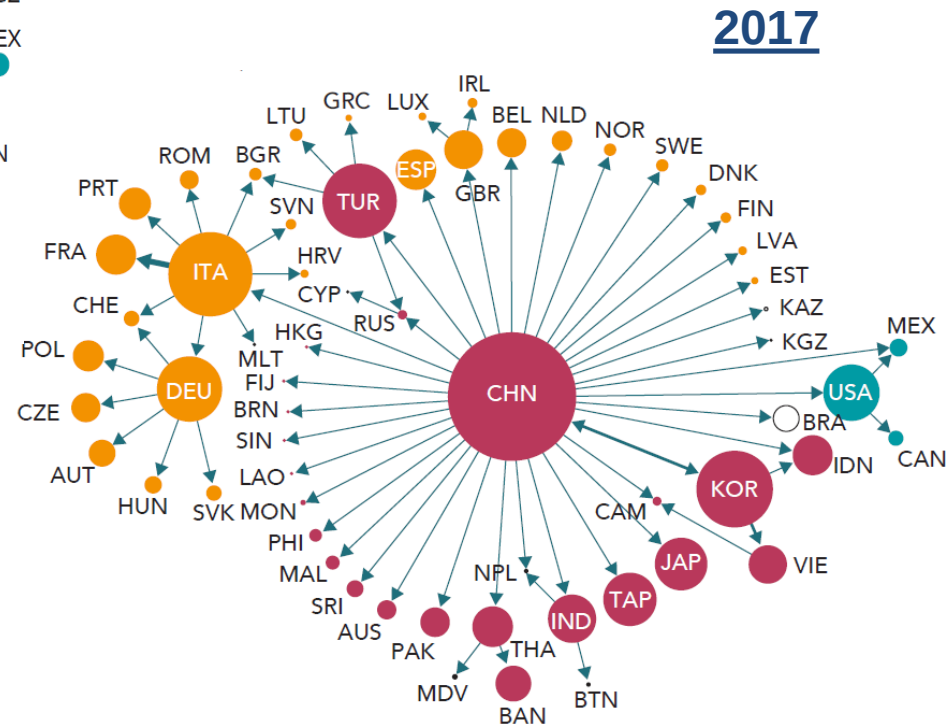
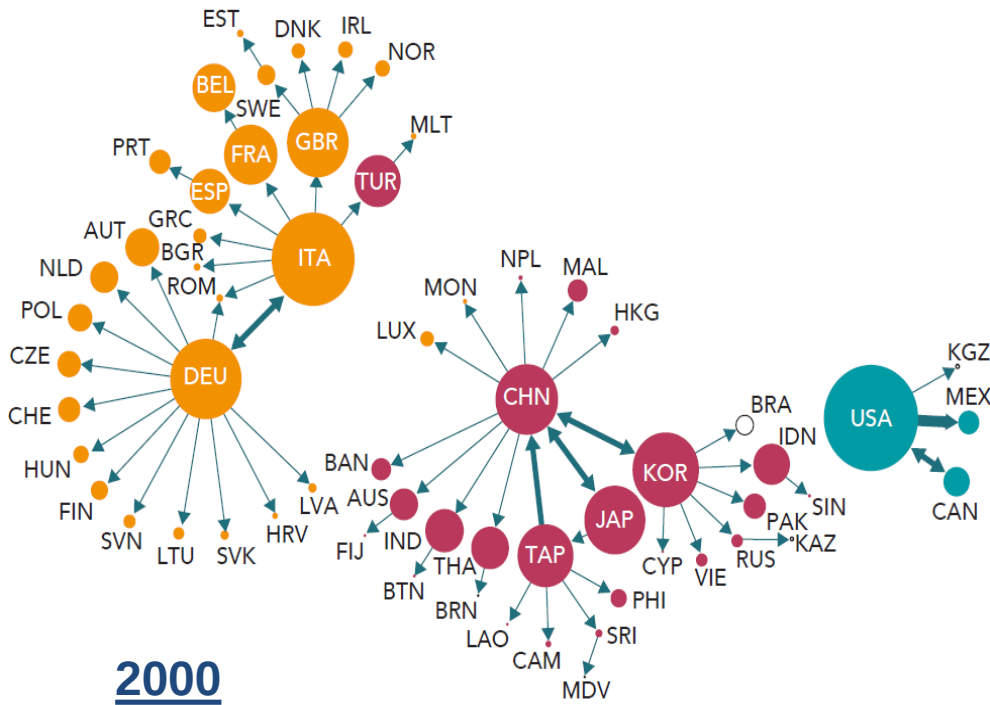
² Peking University, Beijing

* agri45@gmail.com

GVC: Multiple linkages in agri. production network



Textile sector GVC trade network

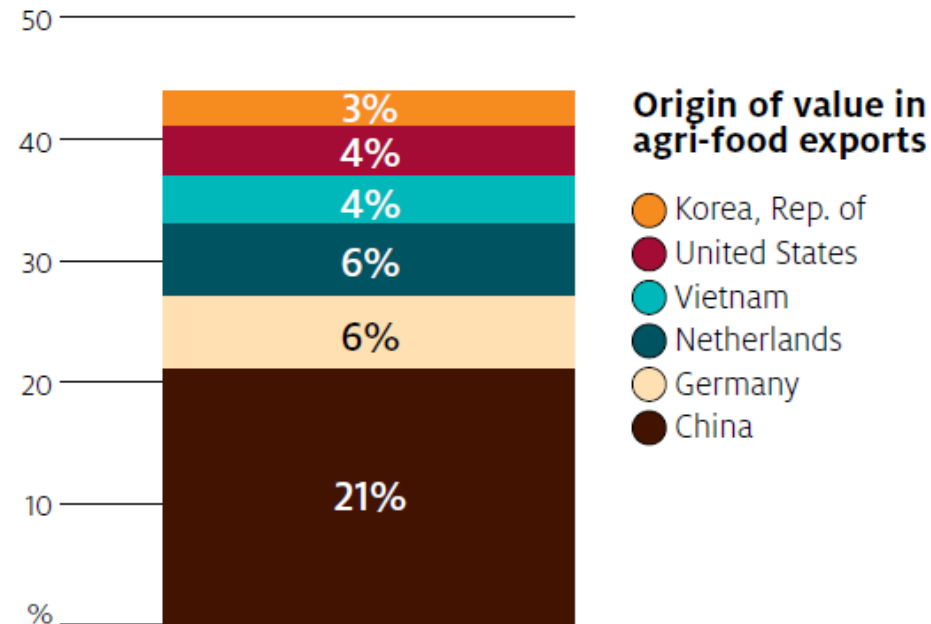


The size of the circles represents the magnitude of value-added exports. The volume of value-added flow between each pair of trading partners is represented by the thickness of the line linking the two.

Source: Meng et al. (2018)

China: The most active player in agriculture and food GVCs, both as a seller of inputs into other country exports and as a buyer of produce for use in its own exports

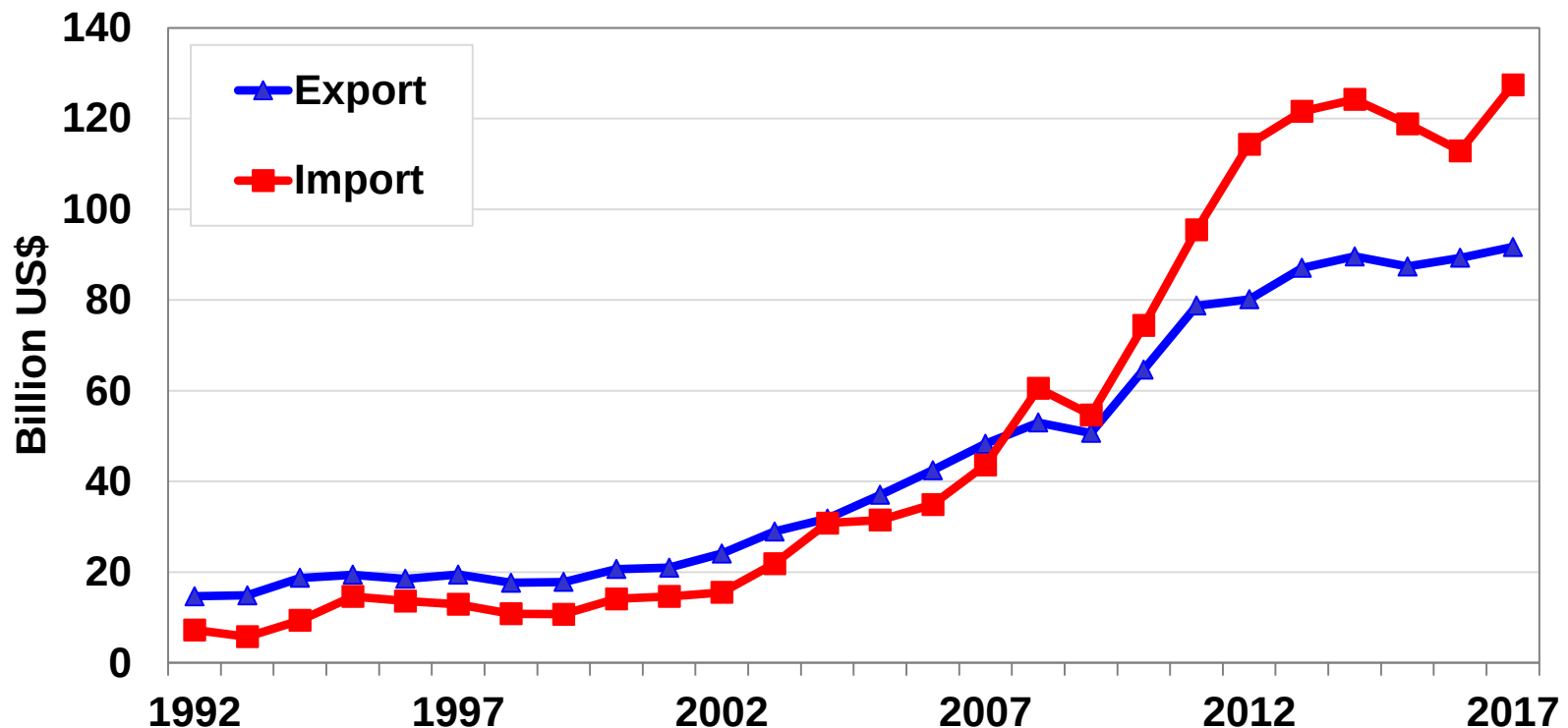
Share of growth in agri-food exports used as inputs into other country exports, 2004–2014



Between 2004 and 2014, China was responsible for 21% of the total growth in forward linkages into GVCs, making it the world's largest GVC concentration point. Similar trends are seen for backward linkage growth, where China also dominates the global share of who is importing for use in exports.

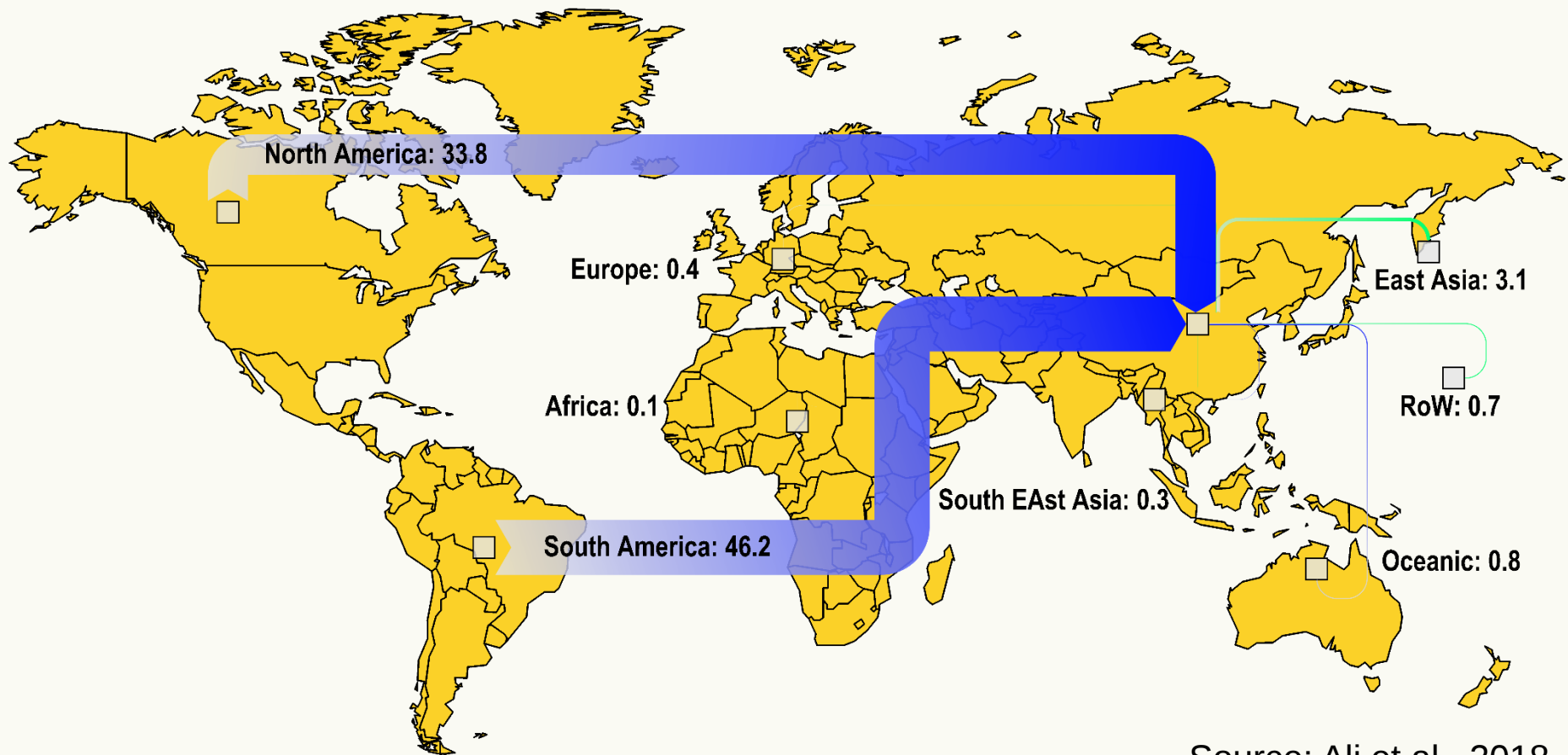
Although China's agri. net imports has been increasing, but we don't know how much is used within China and how much exported/returned

China food trade: export and import (billion US\$)



Previous studies show overestimation of virtual water imports by China; and ignores sharing of responsibility

Origins of China's net virtual water imports in 2011 (billion m³)



Source: Ali et al., 2018

Research questions

- What are the main commodities and regions for virtual water trade for China?
- Where does virtual water imported/ exported by China end up?
- What are the “more accurate” estimates of VW trade?
- Which regions should bear the responsibility in sustainable resource use at global level?

The rest of presentation

- **Methodology and data**
- China's trade in blue and green virtual water.
- The final destination of virtual traded water by China.
- The major regions sharing responsibility for water use.
- Concluding remarks

Methods and data

- **Used global value chain (GVC) method**
 - **Conventional production-based methods don't capture holistic picture of responsibility allocation and sustainability assessment**
 - **Multi-Regional Input-Output Analysis (MRIOA) is an important tool for studying global environmental-related issues.**

Methods and data

Eq. (1) shows different pathways for WEX^{sr} , which is the water embodied in the export from country s to r

$$WEX^{sr} = F^s T^{sr} = F^s T_{f^r} + F^s T_{f^s} + F^s T_{f^{other}} \quad (1)$$

- F^s = a diagonal matrix composed of f_{is}
- T^{sr} = exports from country s to country r
- T_{f^r} = water finally consumed by country r P1
- T_{f^s} = water finally consumed by country s P2
- $T_{f^{other}}$ = water finally consumed by other countries P3

Methods and data

Eq. (2-5) shows the method to calculate F^s .

$$W^{ps} = F^{ps} X^{ps} \quad (2)$$

$$W^{nps} = (W^{ps} - F^{ps} \text{diag}(A^{ss} X^s - Y^{ss} - \sum_{r \neq s}^G T^{sr}) C^{ss})' \quad (3)$$

$$f^{nps} = T^{nps} / (Y^{ss} + T^{sr}) \quad (4)$$

$$F^s = (f^{p1s}, f^{p2s}, \dots, f^{p8s}, f^{np9s}, f^{p10s}, \dots, f^{p18s}) \quad (5)$$

- W^{ps} = the water used in agricultural sectors in country s
- W^{nps} = the water used in non-agricultural sectors in country s which comes from agricultural sectors
- C^{ss} = the ratio of the agricultural products consumed in Non-agricultural sectors
- f_{is} = water intensity of the sector i of country s (both agricultural and non-agricultural sector)

Methods and data

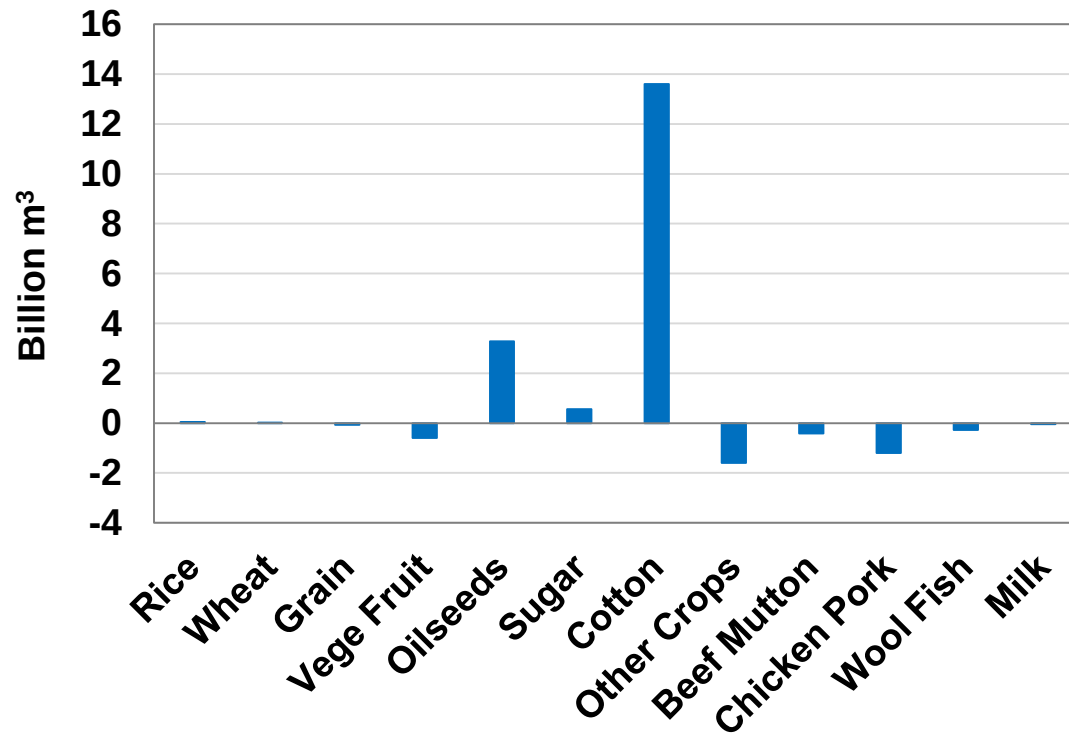
- **GTAP-W database (V9) is used to fill into the corresponding matrices in the MRIOT with subtle adjustments.**
- **Irrigation water requirement of each country (FAO, 2012) is allocated to different crops base GTAP-W.**
- **To get the green VW, we used the blue/green ratios of the water used for crop production (Hanasaki, 2016).**
- **Commodity coverage: 7 crops; 4 livestock sectors (account for >95% of calories >89% of protein) and 3 processed agricultural commodities.**

The rest of presentation

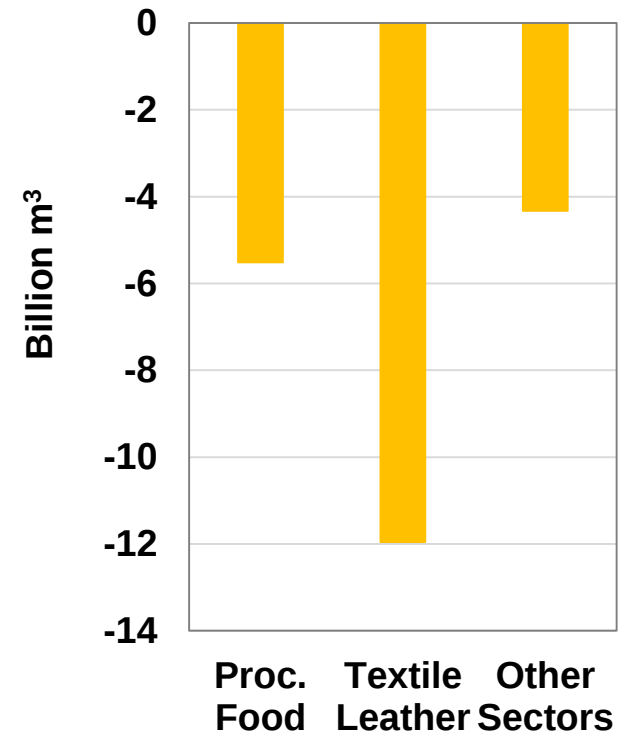
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Blue VW net-imports: primary crops; Blue VW net-exports: processed agri. commodities

Blue VW net-import through **primary agri. commodities** by China (billion m³)



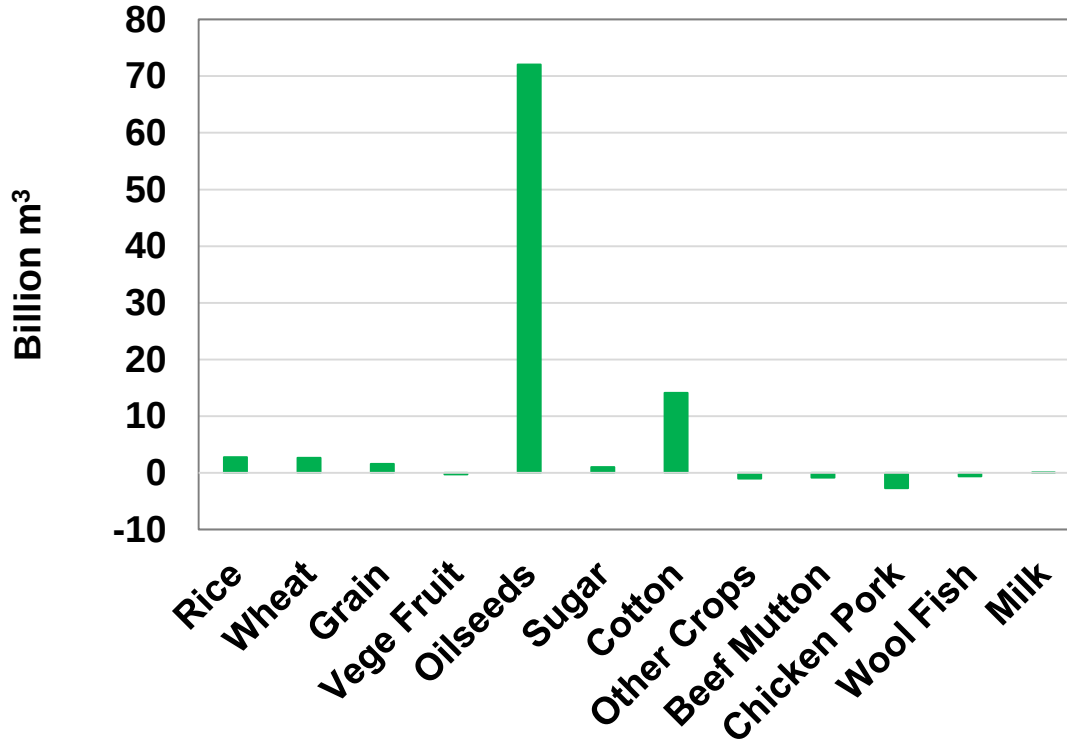
Blue VW net-import through **processed agri. commodities** by China (billion m³)



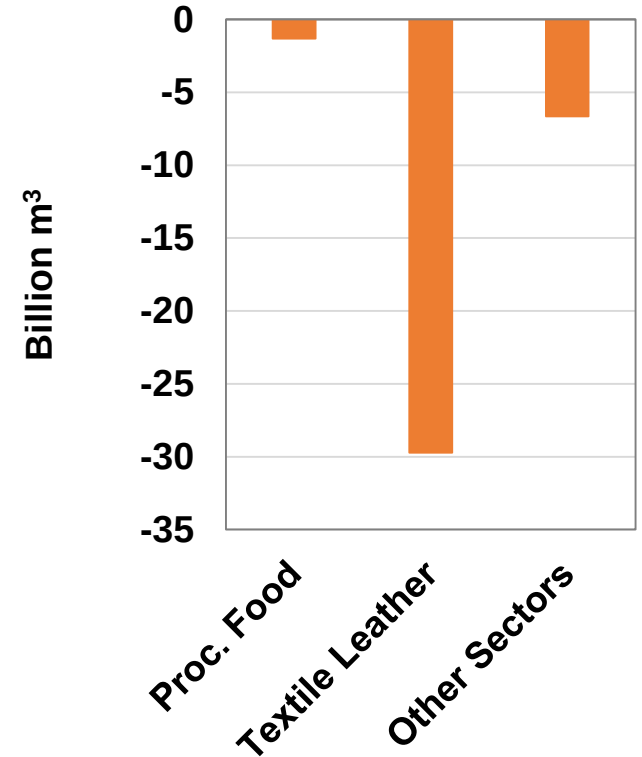
$$\text{Total Net import} = 13.31 + (-21.79) = -8.48 \text{ billion m}^3$$

Green VW net-imports: primary crops; Green VW net-exports: processed agri. commodities

Green VW net-import through **primary agri. commodities** by China (billion m³)



Green VW net-import through **processed agri. commodities** by China (billion m³)



$$\text{Total Net import} = 88.91 + (-37.66) = 51.25 \text{ billion m}^3$$

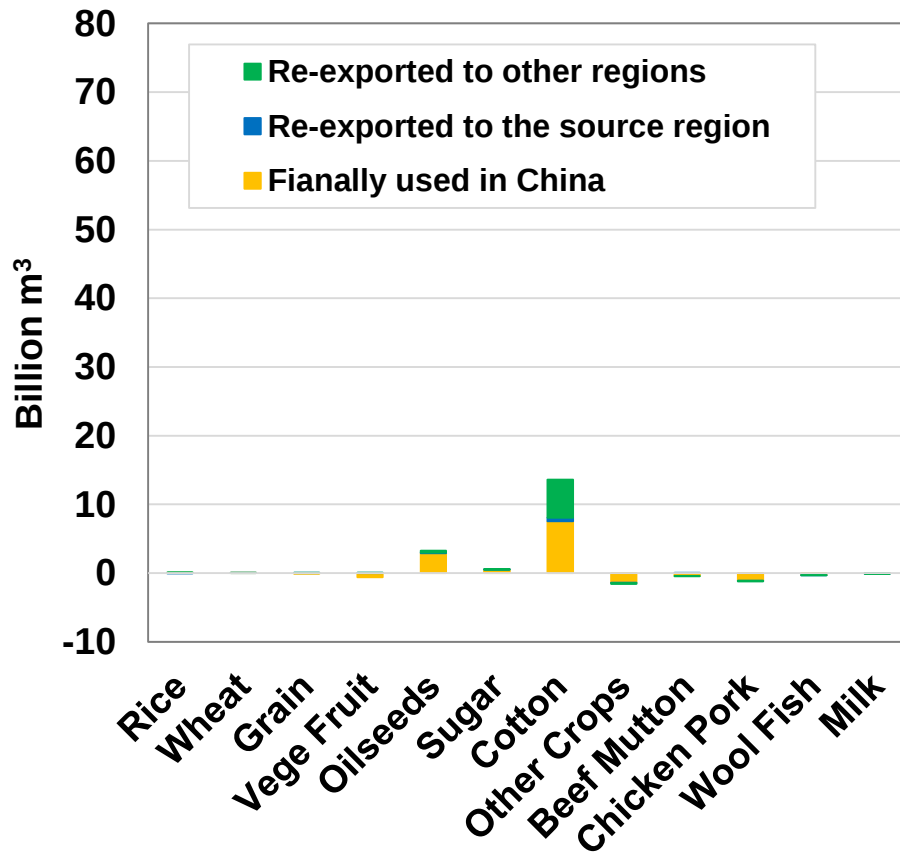
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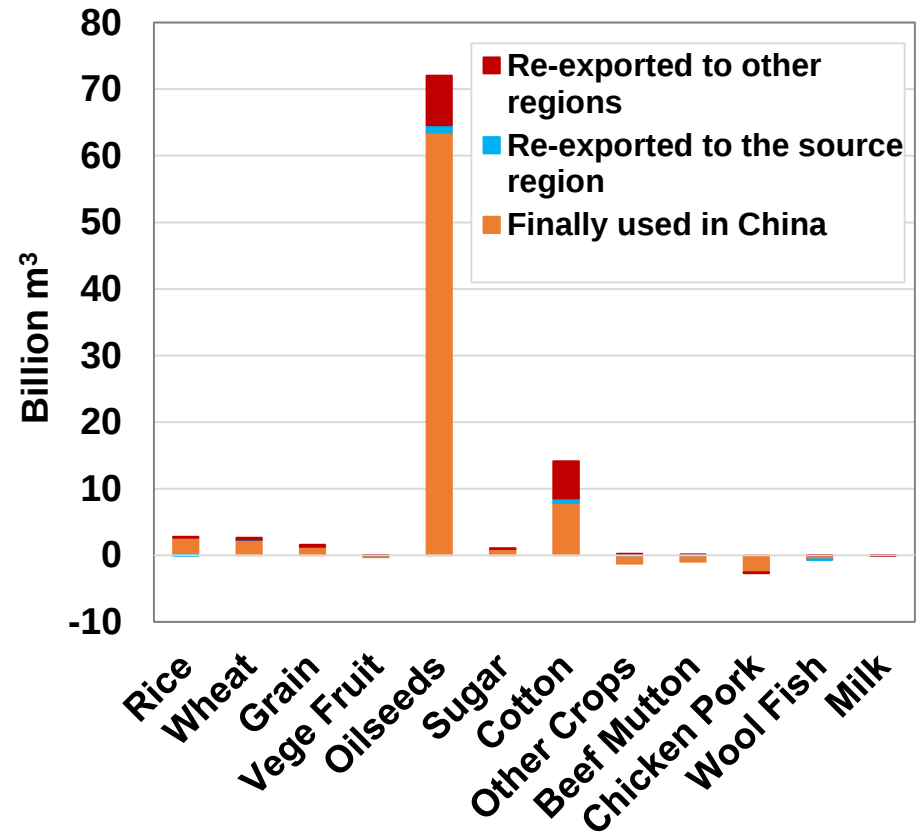
Most of net-imported VW is domestically used in China; still significant portions are re-exported to ROW (Blue 46%, Green 18%)

Net-import of VW through different pathways by China (billion m³)

Blue VW



Green VW



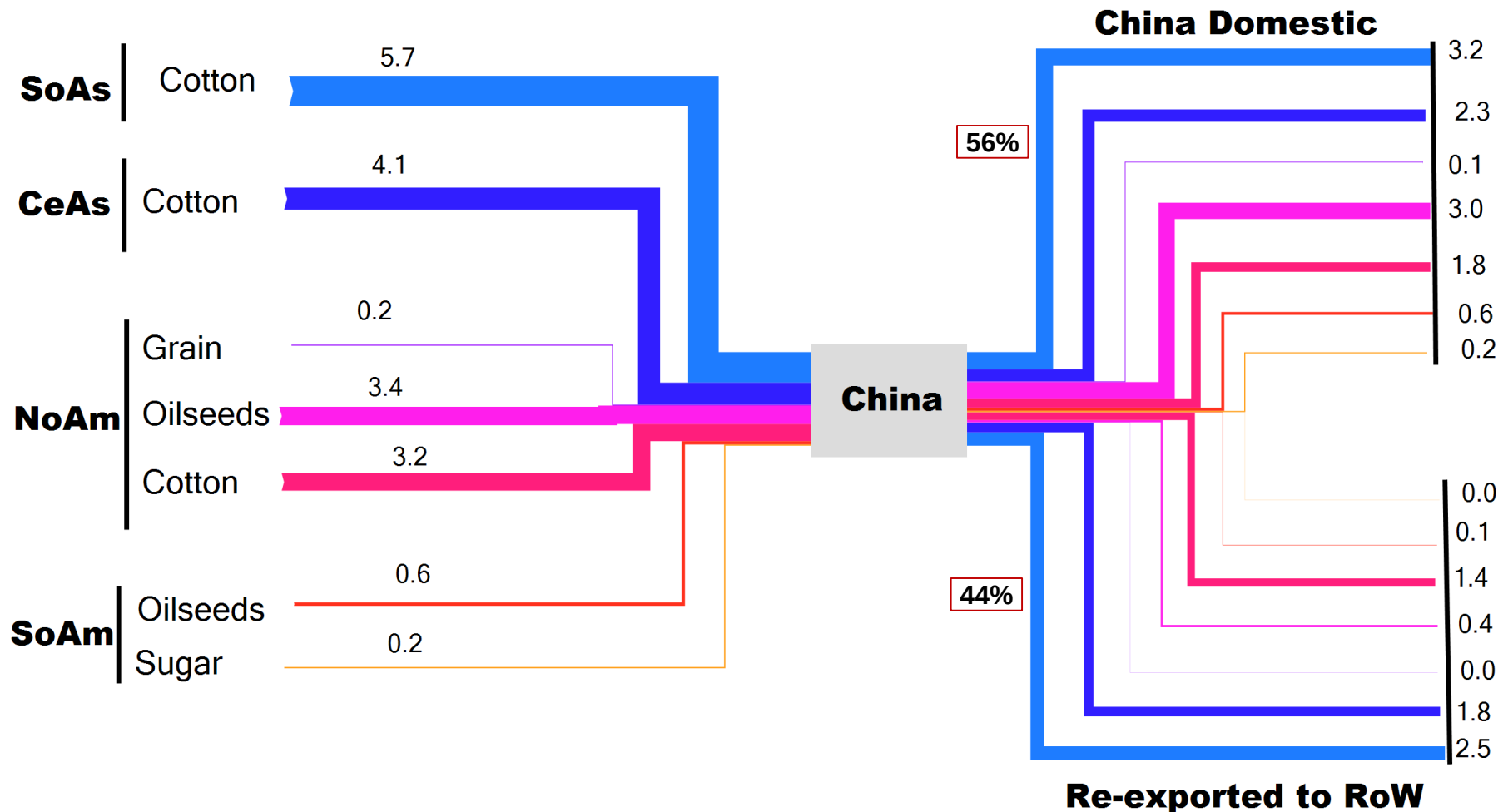
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North America, South America and South Asia are the main sources of net-imports of blue VW

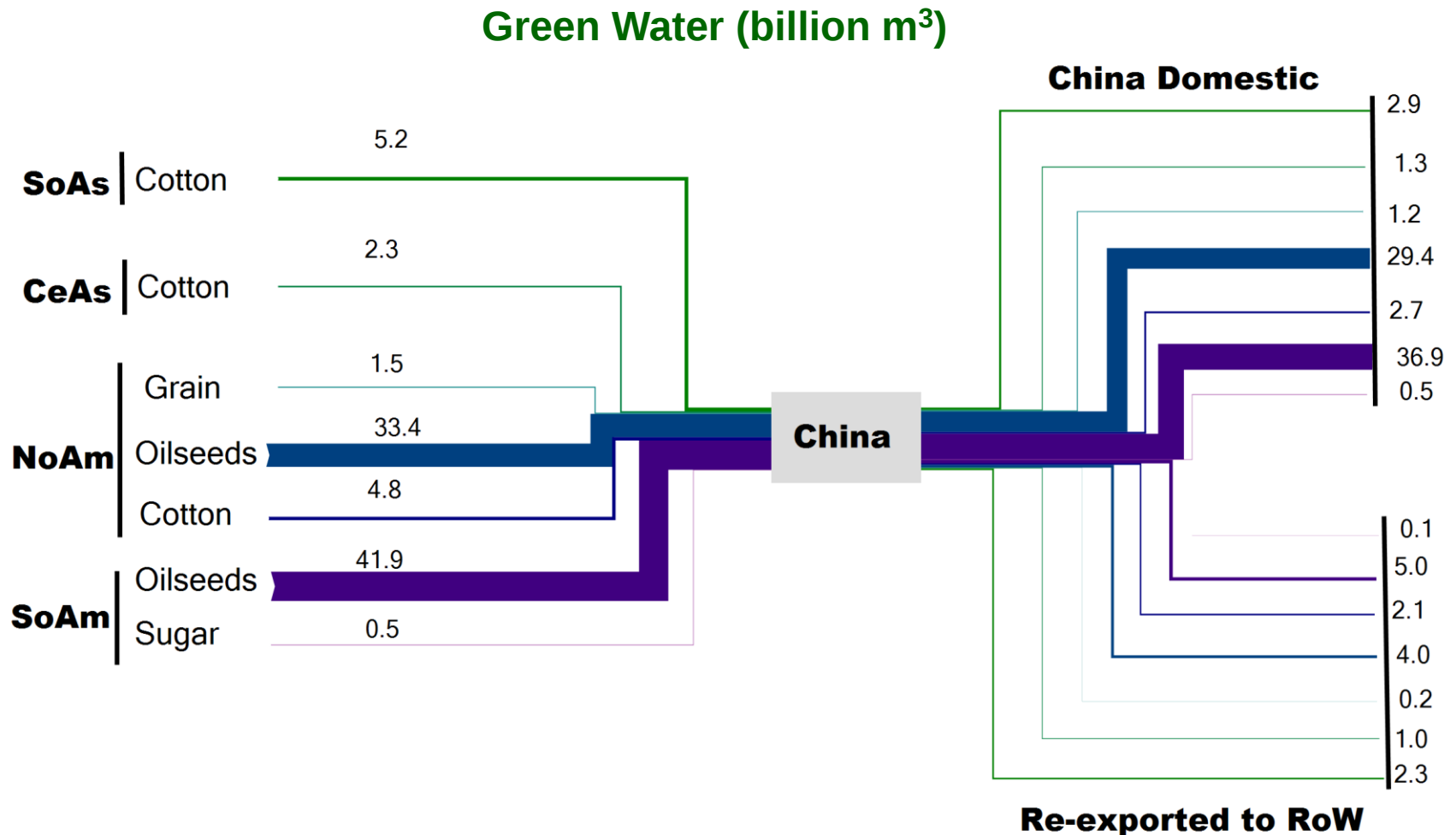
Large share of blue VW is re-exported to ROW

Blue Water (billion m³)



North America and South America are the main sources of net-imports of green VW

Considerable share of green VW is re-exported to ROW



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Concluding remarks

- China is net-importer of blue (more scarce) virtual water through trade in agricultural commodities.
- More accurate estimates: large shares of VW imported by China are re-exported to the source or other regions of the world.
- Each end-user country should share the responsibility for resource use.
- Therefore, global efforts are needed to pursue sustainable resource use.

Thanks!