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A CASE STUDY FOR HANOI, VIETNAM

Urbanisation and demand for construction materials

Tom Bide*, Evi Petavratzi, Teresa Brown, Carolin Kresse and Joseph Mankelow.
*Contact: tode@bgs.ac.uk

Rapid urban expansion and the impact on construction materials supply

Hanoi Province has experienced significant expansion (over 3 300km^2)[1] and population growth over recent years. In line with Hanoi's Masterplan to 2030[2] and current population trends, this growth is expected to continue. Between 1990 and 2016 the percentage of Vietnam's population living in urban areas increased from about 20% to approximately 35%[3].The population of Greater Hanoi has increased from 5.2 million in 2000 to 7.5 million in 2018 (Figure 1) and is predicted to increase to 8.2 million by 2034[4]. In addition the area covered by artificial surfaces has increased from 13% to almost 22% over the same period[1].

Rapid growth of urban population creates significant demand for construction materials, such as sand and gravel, crushed rock, cement, steel and bricks. These provide the materials required for the construction of houses, schools, hospitals, roads, railways and other infrastructure. In Hanoi, plans are already in place for a major new road network, new rail links, an expanded city core, five satellite urban areas and three eco-townships (Figure 2).

Risks to material supply may occur for many reasons, including the lack of material demand forecasts, environmental challenges, natural disasters, political conflicts, inappropriate mineral governance and competing demand from other markets or regions. Such risks can result in supply demand imbalances causing market instability (e.g. Vietnamese sand prices rose by up to 100% in 2017). They can lead to

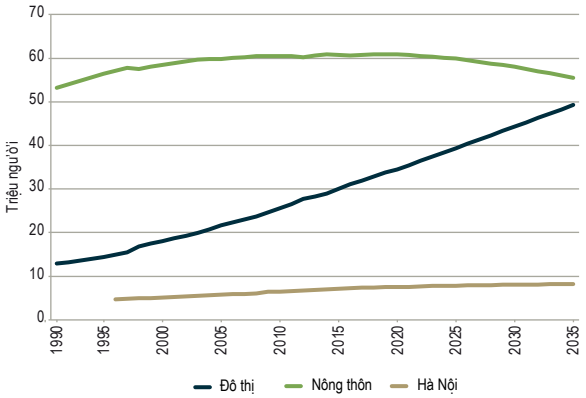


Figure 1 Population in Vietnam and Hanoi from 1990 and projected to 2034.

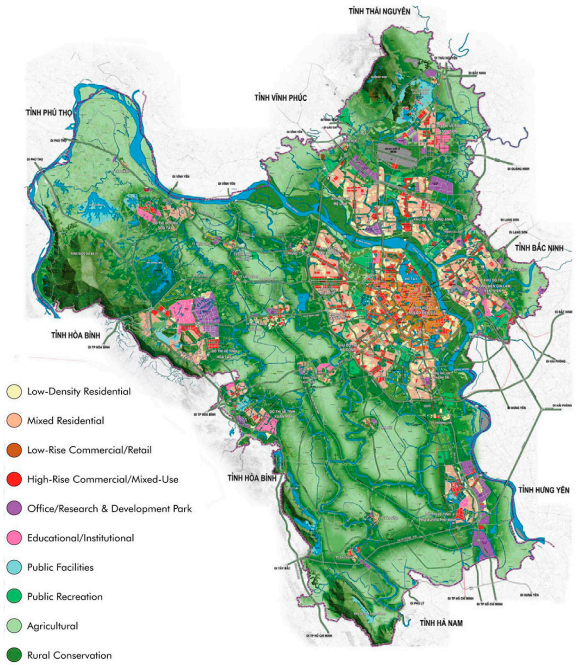


Figure 2 Hanoi master plan 2030. Reproduced from The Hanoi Master Plan with permission from Hanoi Urban Planning Institute.

disruption of construction projects and slow the rate of economic growth.

Global challenges, such as climate change and sustainability are also directly linked to urban expansion. Both the Sustainable Development Strategy for Vietnam[5] and the National Green Growth Strategy[6] present Vietnam's vision to adhere to sustainability principles. If such vision is to be achieved, it is crucial that urban development planners consider where, and how, the raw materials required for construction are sourced in order to ensure sustainable and responsible supply.

Understanding construction material flows

Understanding the flows and stocks of construction materials can help to ensure that supply risks are identified early and urban planning is delivered effectively. This would allow for the development of interventions that manage issues such as price volatility and the lack of transparency of the extractive sector. More information can lead to better decision making, appropriate regulation and a reduction in informal mining practices.

This study aimed to address two key questions regarding the supply of construction raw materials for Hanoi:

- What are the current and future requirements for construction materials in Hanoi to meet the predicted urban expansion?
- What are the implications of the future demand requirements?

The boundary conditions for this study were:

- Commodities = cement, steel, bricks, sand & gravel, crushed rock
- Spatial boundary = city level (Hanoi)
- Temporal = current and future demand
- Flows & stocks = imports, exports, production, consumption

Data availability

An initial data review was undertaken for Hanoi. In many cases, city level data are not available so regional and national level data were used instead along with informed assumptions for the Hanoi province. The datasets used, including their spatial resolution, are shown in Table 1.

Table 1 Datasets used by this study.

Datasets	National		City
Production	Yes[1]	No	No
Trade	Yes/ Partial[2]	No	No
Consumption (demand)	No	Not directly	No
Resources & Reserves	No	No	No
Population growth	Yes[3]	Yes[3]	Yes[3]
Housing demand	Yes[3]	Yes[3]	Yes[3]

[1] from DGMV, statistics office and BGS.
[2] UN Comtrade only has values only, not mass, for many commodities.
[3] from GSOV.

Methods for quantifying material flows

There are several different approaches to quantifying future material flow supply for Hanoi:

- Top-down approach: A prediction of future supply based on mineral consumption and population growth trends; urban growth plans are not explicitly taken into account.
- Bottom-up approach: Future demand is quantified by assessing material demand in current building stock and extrapolating this to meet the urban growth plan requirements. Future supply is quantified using mineral production and population growth trends and compared to identify any shortfalls.
- Dynamic material flow analysis: Detailed quantification of flows and stocks of construction materials in Hanoi.

As detailed data for commodities are not publically available on a city or regional level for Hanoi, a dynamic materials flow analysis was not possible. Similarly, publicly available information that can allow the quantification of building stock is not readily available and further in-depth research is needed to develop this.

Instead the top down approach was selected to quantify future construction material supply (Figure 3). Mineral production and trade data were used to calculate apparent consumption for the selected commodities. Apparent consumption data combined with population statistics then enabled the average consumption per person to be calculated, providing an indicator of material demand.

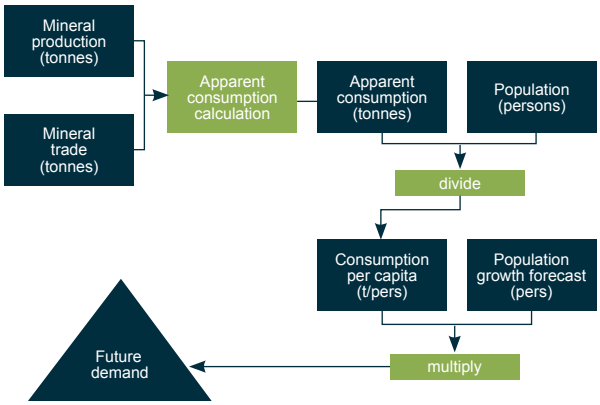


Figure 3 Methodology used by this study.

Results for material consumption

Using the methodology discussed above the apparent consumption for the selected commodities in Hanoi in the last nine years has been calculated (Figure 4). The effects of a slowdown in the construction industry can be seen from around 2010–2012. Changes in policy regarding international exports of sand have also had an effect. However, despite the impact of these external forces the general trend has been one of increased consumption.

One of the largest flows is for sand. However, the reported sand data are expected to be an underestimate due to issues with informal mining that may be taking place in the Red River Delta. The Ministry of Construction, Department of Construction Materials states that the legal sites for sand extraction can only meet 60–65% of demand for major Vietnamese cities[7], this implies the remainder is from informal sources which are not fully documented.

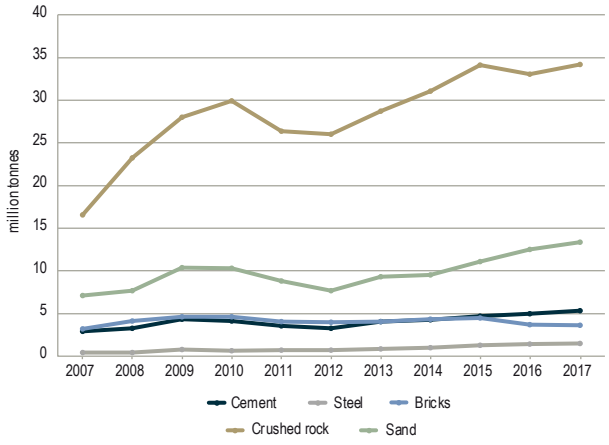


Figure 4 Consumption of construction materials for Hanoi.

We estimate that sand production and consumption was much higher and showing an increasing trend over the past few years. As a result cement has been used as a proxy for sand to predict future consumption using the methodology of the UNEP report into sand and sustainability[8], as concrete is the main use for both sand and cement. This is not ideal however, as sand is also used in non-concrete applications such as mortar, road construction, construction fill etc.

Forecasting demand and implications for material supply

Using projected population growth figures estimates can be made for future demand (Figure 5). Consumption forecasts were based on projections using the compound annual growth rate over a 10 year period.

The graphs forecast consumption (vertical axis) for Hanoi to 2030. The error bars are added to illustrate the potential discrepancies in the main trend line that may occur in the future. That for sand shows both the reported data for consumption and the projections made for estimated consumption using cement as a proxy to 2030.

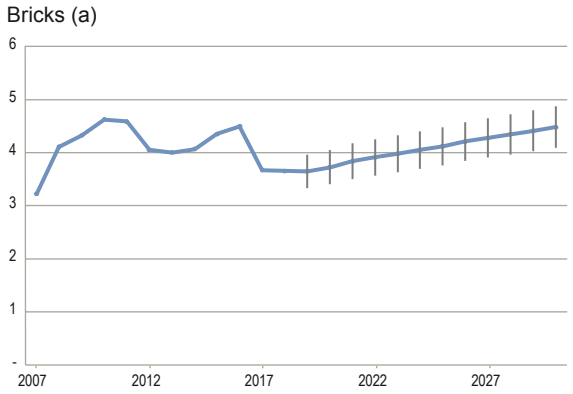
All the graphs indicate that, for all the commodities considered within this study, considerable increases in demand are to be expected. Forecasted demand to 2030 is also summarised in Table 2. This analysis shows that for all commodities demand is likely to more than double over the next 12 years. For materials where supply shortfalls are already an issue, this increased demand will form a serious challenge in sourcing raw materials. There is a clear need for pro-active strategies and planning to maintain supply and avoid negative effects, such as unlicensed extraction.

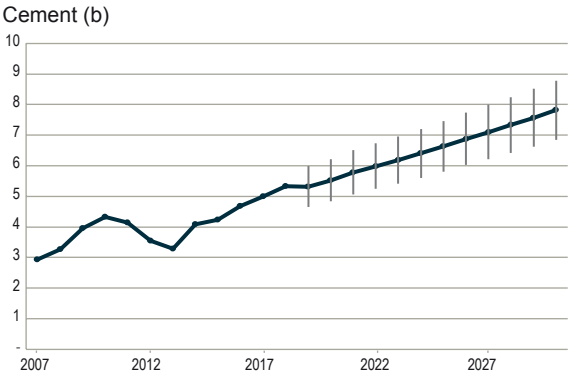
These demand forecasts highlight the need to understand flows of material so that adequate supply can be maintained. New production capacity may be required to meet the increased demand and this will need to be planned to provide timely supply.

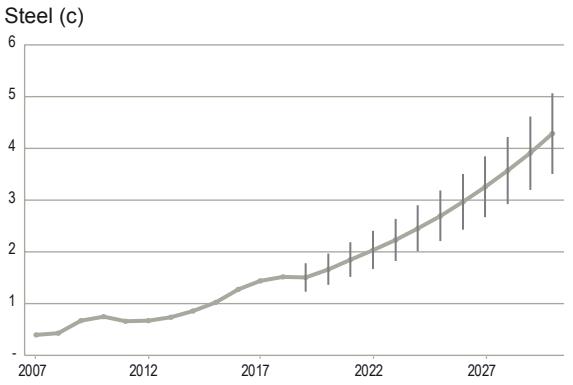
There are also issues with demand from neighbouring regions and countries, which may also require access to the same raw materials. These external factors need to be considered and included in the planning process.

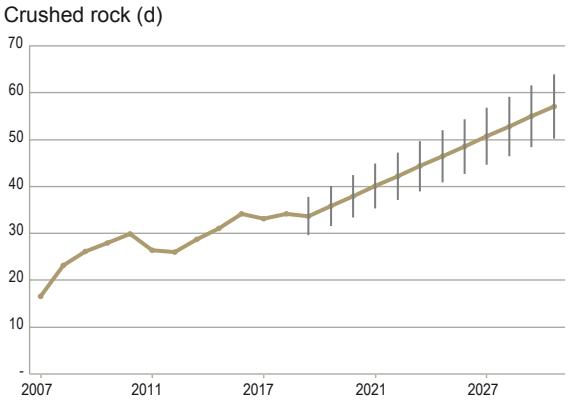
Table 2 Forecast material demand for Hanoi.

Key construction materials in Hanoi	Forecasted demand in 2030 compared to 2018 data
Cement	Increase 1.4-fold
Bricks	Increase 1.2- fold
Sand & gravel (based on cement production)	Increase 2-fold
Sand & gravel (reported figures)	Increased 1.5-fold
Crushed rock	Increase 1.6-fold
Steel	Increase 3-fold









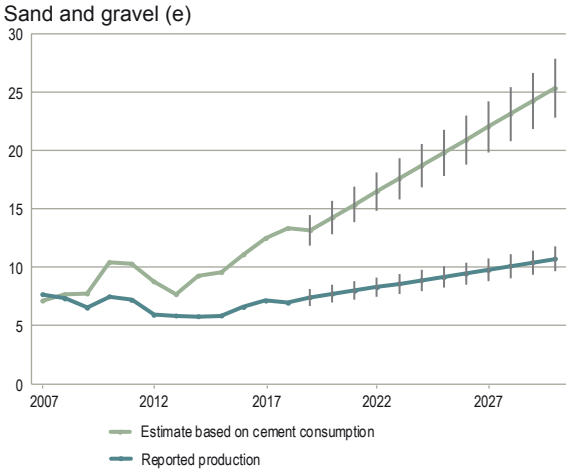


Figure 5 Current and projected figures for consumption of construction materials (Mt), Hanoi. (a) consumption of bricks, (b) consumption of cement, (c) consumption of steel, (d) consumption of crushed rock, (e) consumption of sand and gravel.

If these potential supply and demand imbalances are not taken into account, issues can arise such as high price volatility, informal mining and environmental damage. In addition, it may slow economic growth and hinder major projects if raw materials cannot be accessed.

Outlook

This analysis highlights potential future raw materials supply issues. However, to best understand how to improve supply systems and where policy interventions may be required a more detailed quantification at a regional and a city level is needed.

A better understanding of construction materials flows on a city level will allow for enhanced identification of supply vulnerabilities. Unfortunately data at a regional and a city level on both production and trade of materials is currently scarce.

Information on building stocks will also add a great deal of value to the study. Understanding material requirements in new builds and material use in existing infrastructure enables accurate planning for new supply sources and better use of existing resources, for example secondary aggregates from construction and demolition waste.

The research could also extend beyond construction materials to investigate other aspects of urbanisation, for example changes to natural capital, the transition to low carbon transport and the resulting demand for technology metals. The examination of material flows is highly versatile and useful for addressing sustainable production and consumption.

Footnotes

[1]Data produced using Google Earth Engine from the European Space Agency Copernicus Program and the USGS Earth Resources Observation and Science Center imagery.

[2]Perkins Eastman. 2011. Hanoi Capital Master Plan to 2030.

[3]General Statistics Office of Vietnam (GSOV). 2018. Statistics Database.

[4]General Statistics Office, United Nations Population Fund). 2016. Vietnam Population Projection, 2014–2049.

[5]Viet Nam Sustainable Development Strategy for 2011–2020. 2012. Socialist Republic of Vietnam.

[6]Vietnam National Green Growth Strategy. 2012. Socialist Republic of Vietnam.

[7]Vietnam News Agency. 2017. Vietnam faces severe sand shortage. Vietnam News Agency. [cited 2/3/2018].

[8]UNEP 2019. Sand and sustainability: Finding new solutions for environmental governance of global sand resources. GRID-Geneva, United Nations Environment Programme, Geneva, Switzerland.

Authorship and acknowledgments

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This factsheet has been was authored by Tom Bide*, Evi Petavratzi, Teresa Brown, Carolin Kresse and Joseph Mankelow. (* Contact: tode@bgs.ac.uk).