CHALLENGES IN SPATIAL PLANNING FOR JAVA

R.J. Verhaeghe
Delft University of Technology
P.O. Box 5048, 2600GA Delft, The Netherlands
R.J.Verhaeghe@TUDelft.nl
B. Zondag
Delft University of Technology/Significance
Schipholweg 13, 2316 XB, Leiden,The Netherlands
zondag@significance.nl

ABSTRACT
Spatial development on Java faces a strongly increasing competition for space over the next 25 years. A major driver for spatial development will be urban growth: an increase to a very high 30% urbanized area by 2025, has been projected. The scarcity of land and strong need for conservation will lead increasingly to conflicts of interest between the different sectors. An optimization of land-use, balancing the demands for space from the different sectors, will be necessary. Such strategic analysis requires a quantification of spatial development in order to facilitate comparison of scenario's and options. Different sectors will need to develop policy which addresses the scarcity of land; regional development will be characterized by strong shifts in settlement and employment; urban development will require a strong focus on sustainability (employment balance, mobility, water management); agriculture will be faced with a reduced area and an increasingly urbanized market; inter-regional transport will need to be strengthened in order to support the modern sector of the economy; an adequately justified conservation zoning (ecology, erosion, run-off) needs to be established most urgently as part of a sustainable spatial development strategy, and will be essential for local and regional authorities to resolve local versus regional interests. The results from the "Integrated planning for space and water" project are used to elaborate/illustrate those challenges in spatial planning.

Keywords: land-use competition, optimization, quantified projections, sector policies

1. INTRODUCTION

Strong demographic changes and increasing economic activities over the next 25 years will stretch available resources of land, water and environment on the island of Java to the limit.
Sustainability of socio-economic – and physical systems is becoming a major issue for Java; the demand on resources is strongly increasing while the supply capacity is decreasing. For example water systems appear highly sensitive to an increasing land-use intensity; uncontrolled settlement and non-adapted land-use practices up to now have had a strong adverse impact on runoff; at the same time the demand for water and the impact from flooding are increasing. Climate change is expected to further negatively influence the supply by causing more high intensity storms as well as more extreme drought situations.
Major congestion can be observed in the larger cities seriously hampering economic activities.
Inventory of remaining forest areas indicates that all but a few DAS have a percentage forest cover which is (far) below the 30 %; such minimum percentage is set as a target for an environmentally healthy catchment (DAS) in the New Spatial Law (2007).

Pro-active planning to address the challenges will require a combination of resource management, regional planning, infrastructure development, and protection through zoning and regulation, to optimize overall welfare. Spatial planning, defining the primary situation and spatial balance between sectors, will play a major coordinating role in this.

Java island will increasingly experience a scarcity of land resources, resulting in a strong competition for space. A rational basis, using quantified information from different sectors, will be required to prepare for decision making to resolve competitive claims; this means a quantification of interests and impacts. For this quantification a spatial modeling, which allows to trace the impacts of alternative allocations of space, will be essential.

Spatial planning will play a crucial role in a pro-active planning to address problems in different sectors. The present paper reviews the role of spatial planning in such pro-active planning and more in particular addresses the role of modelling to quantify options and trade-offs. This is illustrated in the different sections below as follows:
section 2 gives a sketch of a recently developed spatial model (Java Spatial Model[1] : JSM) and its use to project land-use for Java; section 3 discusses urban development policy; the challenges for development of mobility are discussed in section 4; the consequences of the strong land-use changes for agriculture are reviewed briefly in section 5; consequences and challenges for the water sector and in particular conservation are discussed in section 6; establishing a sufficient spatial planning will pose organizational challenges which are briefly elaborated in sections 7; key observations and findings are summarized in section 8.

2. SPATIAL PROJECTIONS FOR JAVA – SPATIAL MODEL

General

The forecasting of land-use changes is important for two reasons:

- Different sectors (e.g transport, energy, water, etc.) need information for the mid and long term about the spatial distribution of residents, firms and land-use as input for their planning and evaluation of investments. An improved quality and consistency of this critical input data will improve policy making in the different sectors;
- Insight in the future land-use changes and their consequences (via maps and impact indicators) are an essential input to formulate public policies and regulations aiming to avoid unsustainable developments (e.g. zoning to protect flood plains or upsteam areas with a high impact on run-off peaks from future urban development)

Spatial modeling, allowing to project future settlement, based on a representation of spatial processes and scenarios, and its application to the spatial development of Java is reviewed in the paragraphs below.

Drivers of land-use change

The ongoing transformation of non-urban area into urbanized land is caused by developments in spatial markets like the housing market, labor market, and transport market. These markets

[1] model prepared in the project "Integrated planning of space and water"; project carried out for the Ministry of Public Works, Direktorat Jenderal Penataan Ruang.

change under influence of several interacting driving forces; important drivers are demographic and socio-economic drivers. A good understanding of these drivers, how they are going to develop and differ among regions, is important for modeling future urban land-use.

Demographic drivers are especially important to project future residential land demand. Key drivers for additional residential land-use are:

- Population growth;
- Household size reduction;
- Increasing use of land resources per household as wealth grows.

For the coming decades all three factors will result in additional demand for residential land and, for example, the decline in average household size was in the period 1990 - 2000 a more dominant factor explaining the growth in urban land-use than the population growth on Java. Establishing the total need for additional residential land is based on a multiplication of these three factors. Although the population growth slows down on Java, projected around 20% for the period 2005-2020 (BPS), the total additional need for residential land will be high and is forecasted to be above 70%. It should be noted that this growth will be unevenly divided over Java, mainly varying by differences in economic developments. Simply applying a standard factor is therefore no option and a spatial model is needed to capture the regional differences.

Key *Economic drivers* for land-use change are:

- Economic growth and associated employment growth;
- Land-use by employee;
- Changes in economic structure

The demand for industrial and commercial land is driven by changes in employment for these sectors. Key measure for economic growth is the growth of GDP; the economic growth consists of a productivity component and an employment component. The GDP growth over the last 15 years on Java is more than a factor 3 higher than the growth in employment showing that the productivity component is larger than the employment component. It should be noted that substantial differences exist in employment growth between the various regions on Java. For example, the average annual growth rate of employment in Jakarta has been a factor three higher than for the provinces of East or Central Java.

The economic structure of Java has changed significantly over the last 15 years; the employment share of agriculture has declined from 49% in 1990 towards 36% in 2005 (BPS data). The employment share of the industrial sector has increased form 11 to 22% in the same period (service sector from 40% to 42%). It is obvious that these changes in economic structure were an important driver of the growth of industrial and urban land-use. It is likely that in the future an additional shift from employment in the agricultural sector towards the industrial and service sectors will take place.

The *trends in spatial developments* depend on the spatial scale level: at the inter-regional level a centralization trend can be observed driven by agglomeration forces (e.g. Greater Jakarta region); however at a regional level suburbanization (or decentralization) is the dominant trend; on Java this can be observed in the regencies neighboring Jakarta in the provinces of West-Java and Banten. Key drivers of suburbanization are housing preferences and improved transport conditions (higher car ownership rates, improved road conditions) facilitating longer commuting distances. For example, it can be expected that the development of a highway network on Java will have a big impact on spatial developments. Spatial planning will be needed to protect the interest of other sectors and to ensure that urban development takes place at desired locations.

Structure of the prototype Java Spatial Model (JSM)

Key principles in the design of the Java Spatial model are the following:

- Layered structure to capture the different spatial trends of centralization at an interregional level and suburbanization (or decentralization) within a region;
- The modeling is dynamic and uses time steps of one year; this reflects the incremental nature of spatial changes and enables to model the time path dependency of developments;
- Key feature of the model is its spatial detail, the model is capable of calculating the impacts on the spatial distribution of residents/employment and associated land-use changes of different socio-economic (or demographic) scenarios and/or policies at the level of desa units;
- Flexible structure based on the use of separate interacting modules.

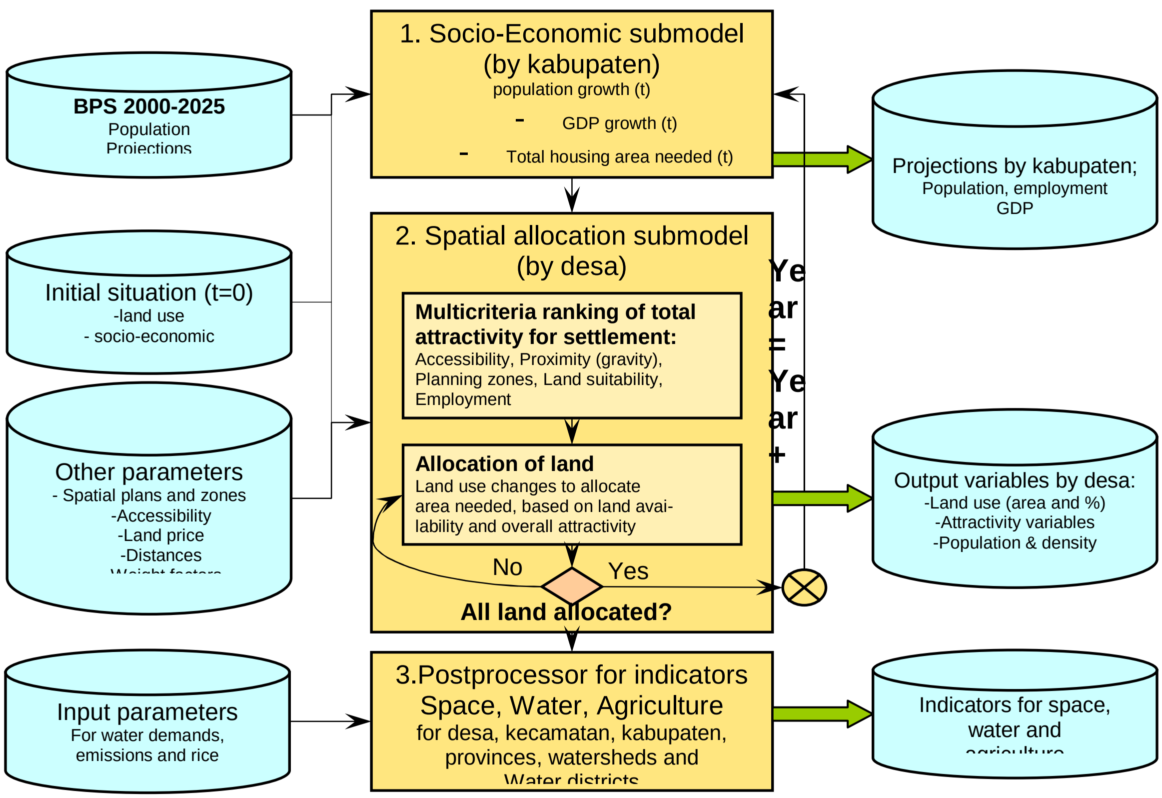


Figure 1: Functional flow diagram of the Java Spatial Model (JSM)

Figure 1 presents the structure of the model comprising a socio-economic module, addressing differences in development at a regional level, and a spatial allocation module addressing the changes in number of residents and employment and associated land-use changes at a local desa level (27000 desa's on Java). Further a post processing module is developed to generate (at present a limited number of) indicators for land-use, agriculture and water.

Economic development as driver of regional change:
at a regional level economic developments are the main driver behind migration streams and there is a clear difference between the economic and population development in the rural and urban regions on Java. The regional module of the Java spatial model addresses these regional differences in economic development and the associated migration pattern (e.g. migration stream from Central and East Java towards Greater Jakarta region). The regional module in the JSM operates at the level of Kabupaten and has been estimated based on BPS data on employment status and population for the period 1990-2000. The module distinguishes three different economic sectors, namely agriculture, industry and services.

Figure 2 presents the forecasted regional development in employment at the Kabupaten level. Exogenous projections by economic sector have been used at the Island level. The map shows the differences in development between urban and rural regions and the agglomeration advantages of the greater Jakarta region. At the level of economic sectors there is an ongoing change in economic structure from agriculture towards industry and services.

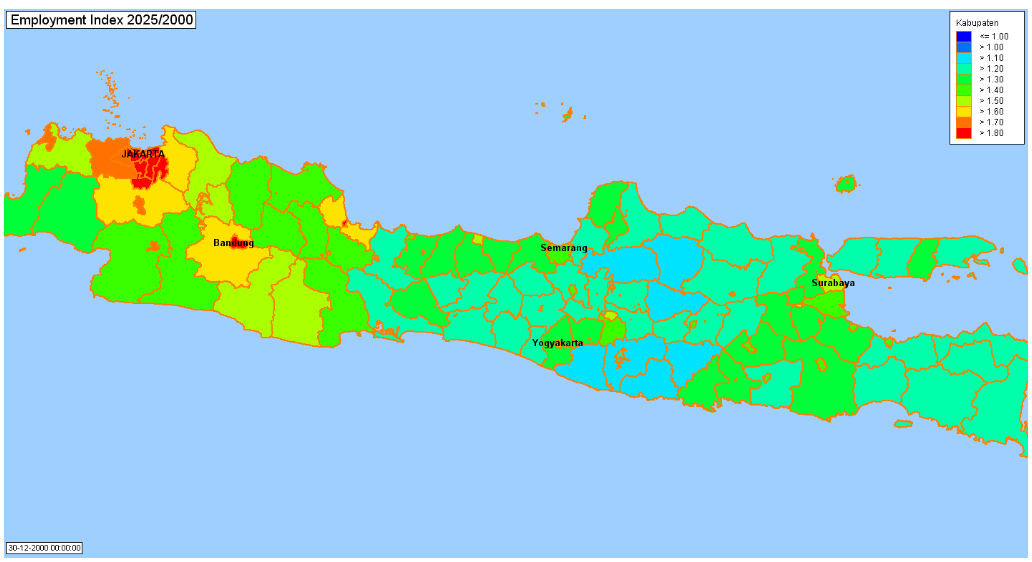


Figure 2: Simulated employment growth by Kabupaten

Figure 3 presents the forecasted population growth at the level of Kabupaten as forecasted with the regional module of the JSM. This model uses population projections at the Island level from BPS as input and the output of this module is input for the desa model within the JSM. The population development in a region is strongly affected by the development in employment in the region itself and surrounding regions via a spatial interaction matrix. Other factors affecting the population development are land availability and spatial policies. The functioning of the model can be illustrated by the high population growth in the Kabupaten Tangerang and Bogor. This is driven by the employment growth in Jakarta and lack of space in the Jakarta region itself and kota Tangerang and Bogor (a similar pattern can be observed surrounding Surabaya). The impact of spatial planning, model settings assume in this case that the draft Java Bali spatial plan has been formally adopted, can be illustrated for the Kabupaten Bekasi and especially Bandung where most of the land is protected as natural or agricultural conservation area. Alternative model runs for the Bandung region, without implemented conservation zones, show a high population growth for this region instead of the modest increase as presented on the map.

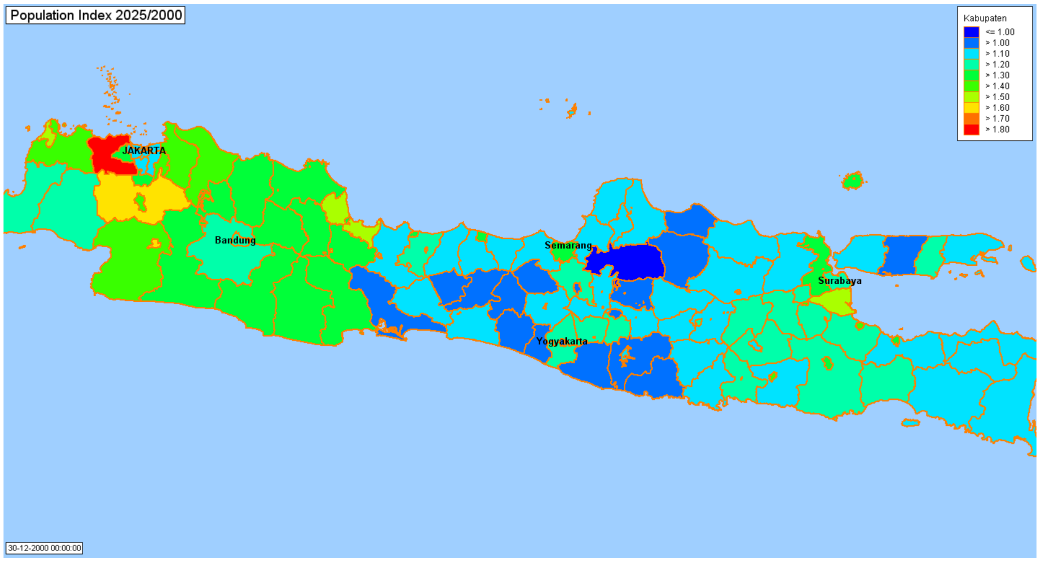


Figure 3: Simulated population growth by Kabupaten

Forecasting land-use changes – setting the policy challenge

The strong increase in urban land on Java will have strong implications for other types of land-use. The maps in Figure 4 present the calculated (JSM) results for the growth in urban land on Java for the coming 25 years. This calculation is based on the long term demographic scenarios of BPS for Java as a whole and drivers of urban land-use changes as specified above. As reference for policy setting the zoning from the present draft Java Bali spatial plan is included. The maps show that the growth in urban land is ongoing at a high speed (due to a combination of drivers as population growth, declining household size and increasing welfare) and an increase of 70% in urban land is predicted for the period 2000 -2025. The growth in urban land is mainly in competition with irrigated areas and if no further policy actions are taken a substantial loss of irrigated area will be the consequence of this ongoing and unrestricted urban growth. Due to this loss in irrigated area rice self sufficiency for Java (currently close to 100 %) will drop under 80%, and the island of Java will become a net importer of rice.

The maps of land-use changes on Java illustrate the ongoing strong changes in land-use which in combination with existing problems makes it clear that a continuation of a largely unplanned and unrestricted spatial development will have severe consequences for the natural and living conditions on Java. The challenges are recognized in the New Spatial Law (2007), and the challenge is now to implement an efficient spatial planning framework capable of protecting the interests of the 3 p's (people, planet and profit). Below the contribution of the JSM to such spatial planning framework is briefly discussed.

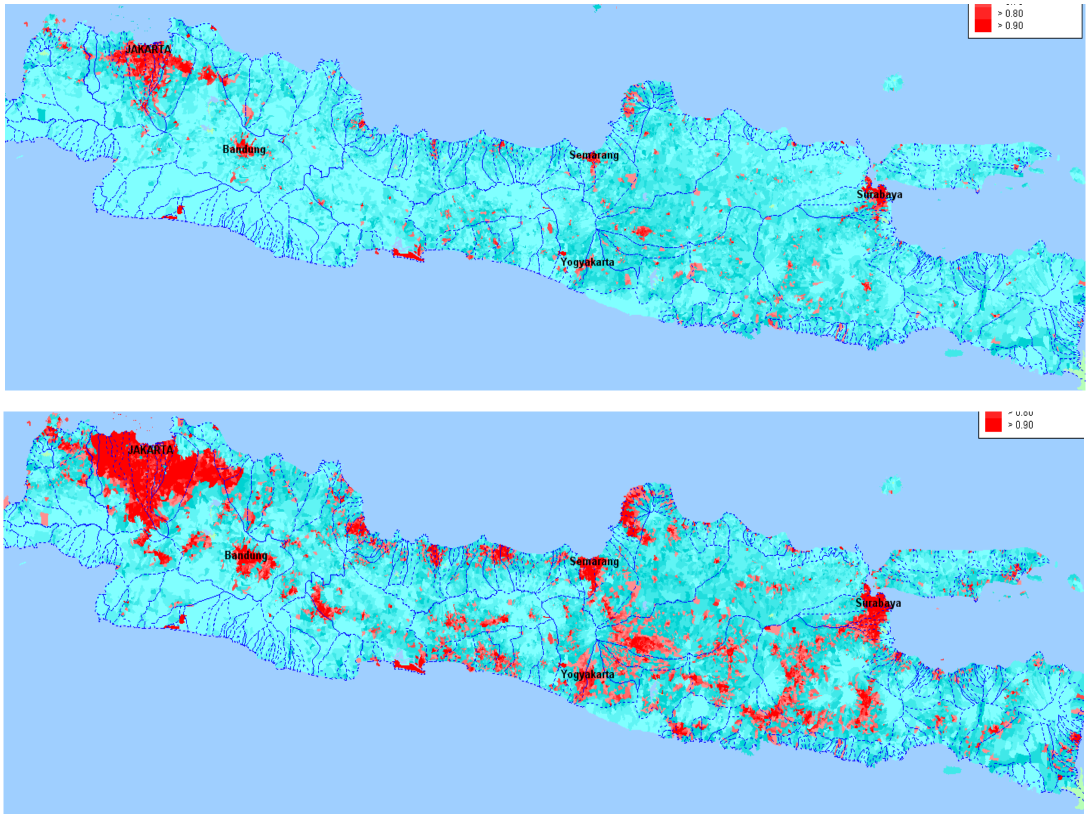


Figure 4: Urbanization on Java, urban area 2000 and urban area 2025 (projected with JSM)

Contribution of JSM to spatial policy making

The complexity of spatial policy making is that it is in its nature a multi-sector and multi-level activity. Many different sectors (e.g. housing, forestry, agriculture, water, etc.) put claims on land and it is a key function of spatial planning to develop an integrated multi-sector spatial plan. The spatial planning agency has to perform a multi-sector analysis, focusing on the land claims from the different sectors, to develop such integrated spatial plan.

A multi-sector analysis will require to resolve conflicting claims and to make trade-offs. For example, conservation in upstream regions might result in a shift of residents and firms to downstream regions. Such additional need for urban land in downstream regions might conflict with the preservation of sawah areas. A tool such as JSM can be used to identify the kind of choices which need to be made. Such information is critical to inform policy makers and develop a spatial plan which contributes as best as possible to overall societal welfare.

By providing transparency and visualization, application of such quantitative approach can strongly facilitate the process of negotiations with different sectors and tiers of government which is necessary to establish an overall agreed spatial plan, a necessity for implementation. The political process of negotiations with different sectors and tiers of government is illustrated in Figure 5. As indicated above, a land-use model can help a Spatial Planning Agency in this process by improving the collection and processing of spatial data, facilitate communication based on presentation of alternative land-use forecasts in thematic maps, and identification of areas of conflict and trade offs. The process of interaction with the sectors is dynamic in nature but needs clear procedures for interaction to clarify discussion points and deliver well defined "Spatial plans" at regular intervals in time.

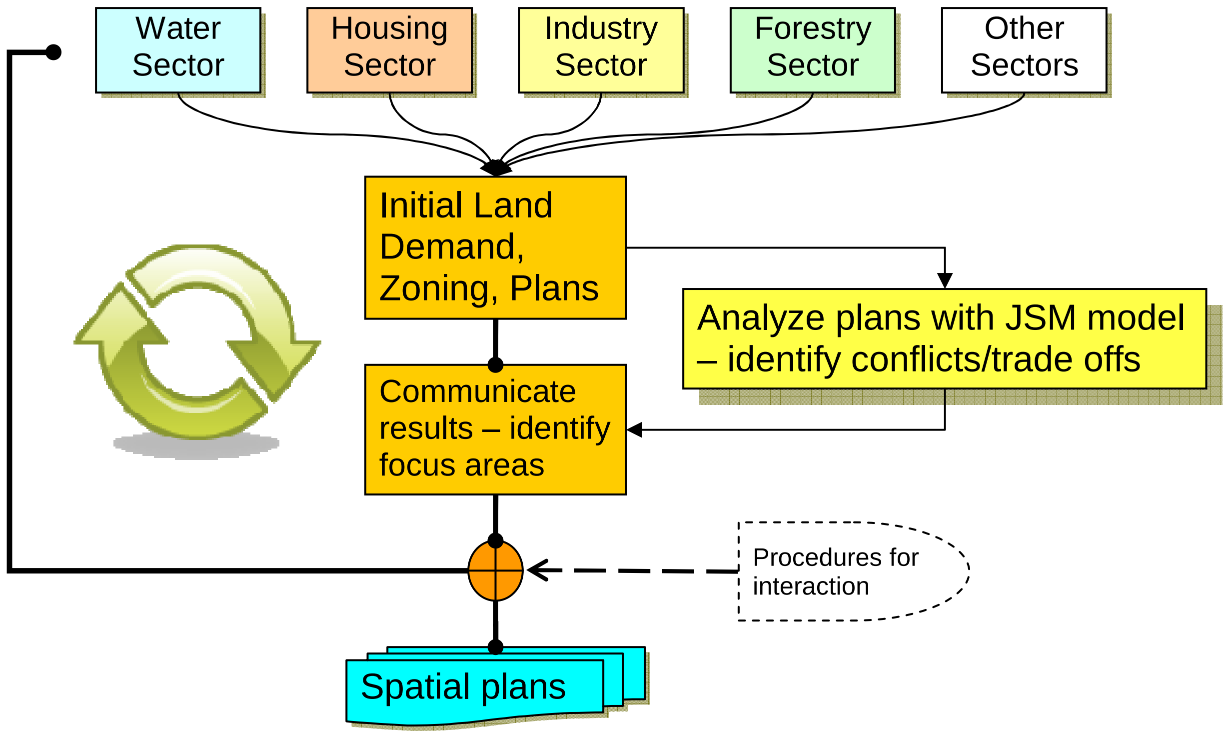


Figure 5: Role of the spatial projection model in the negotiation process to implement spatial plans

3. URBAN DEVELOPMENT POLICY

Like many other megacities in the world the city of Jakarta has grown out of its administrative boundaries (DKI) into the neighbouring provinces of Banten and West-Java. The population growth of the agglomeration of Jakarta, especially DKI, is fed by an ongoing influx, driven by higher employment growth figures, higher average income levels and education opportunities, of migrants from other parts of the nation particularly from rural regions of Central and Eastern Java. The lack of space within DKI and preferences for a suburban livestyle, especially once people have started a family, results in a large outmigration or suburbanization into the kabupaten surrounding Jakarta (Bogor, Bekasi and Tangerang). Result of this two processes is that in the period 1990-2005 the population of DKI Jakarta has increased modestly from 7 to 9 million and the population in the surrounding regions (Kabupatan en kota Bogor, Bekasi, Tangerang and Depok) has more than doubled in the same period from 6.6 million towards 13.2 million.

This trend is expected to continue, the maps in Figure 6 present the size of Greater Jakarta in 2000 and the forecasted size (JSM) of this metropolis in 2025. The development is largely unrestricted with the exception of the protection of the Sawah area in the North-East of Jakarta, which is specified in the draft Java Bali spatial plan. The map shows that the urban area is even growing out of the existing greater Jakarta region (Jabodetabek) into regions (kabupaten) Serang and Karawang as well, for this whole region the population is projected to grow from 24.7 million in 2000 towards almost 34 million people in 2025.

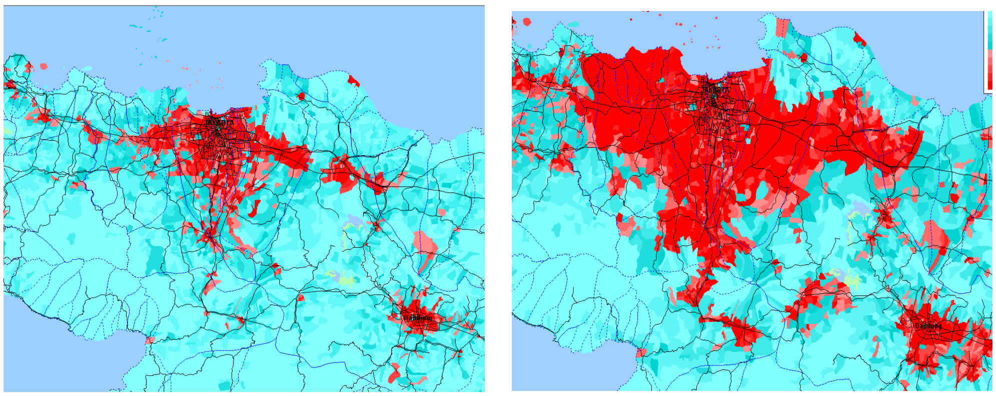


Figure 6: Greater Jakarta in 2000 and 2025 (forecasted with JSM)

The forecasted large increase of the urban area of greater Jakarta is likely to deepen existing problems with water floods, water quality, transportation, urban climate (lack of open areas and trees), etc. An urban development strategy is needed to cope with this challenge and the JSM has been used to explore an example of such strategy, namely the network city concept. Principle of the Network city concept is to limit urban area growth around Jakarta in such a way that a network of a compact Jakarta and satellite cities is created

The network city concept has been implemented by using a combination of three strategic measures as follows:

1) Regional development strategy: this strategy aims to reduce inflow to greater Jakarta region from especially central and eastern Java by creating opportunities in other regions and limiting available space in the greater Jakarta region;.

2) Use of zoning policy to protect open space surrounding Jakarta. The zoning policy is used to cluster urban development into the satellite cities;

3) Use of urban densification strategies in existing and new urban areas. Part of the additional urban land claim is caused by lowering population densities as household sizes are decreasing and land-use by household is increasing. Many cities in the world, examples can be found in Europe and Japan, have responded to this trend by an active urban densification strategy to increase the number of dwellings within the existing urban area.

The impact of measure 1) on land-use change will be modest as experiences show that regional development strategies reducing migration flows are difficult to implement successfully. In the example case the growth of the Greater Jakarta region, due to this measure slightly reduces from 34 million in 2025 towards 32 million (from 24.7 million in 2000). Measure 2) and 3) are much more important measures as they aim to reduce the negative impacts on land-use caused by key drivers such as declining average household sizes and suburbanization. The assumption for the densification strategy is that the falling urban densities, as part of the trend, can be reduced and densities stay closer to the existing population densities in 2000 (as a limit or reality check on the strategy, it has been set that in none of the regions the population density may become higher in 2025 than in 2000) .

The map in Figure 7 illustrates the urban development of greater Jakarta in 2025 if the network city concept is implemented. It should be noted that the network city case represents the situation in which there is an active and inforced spatial planning.

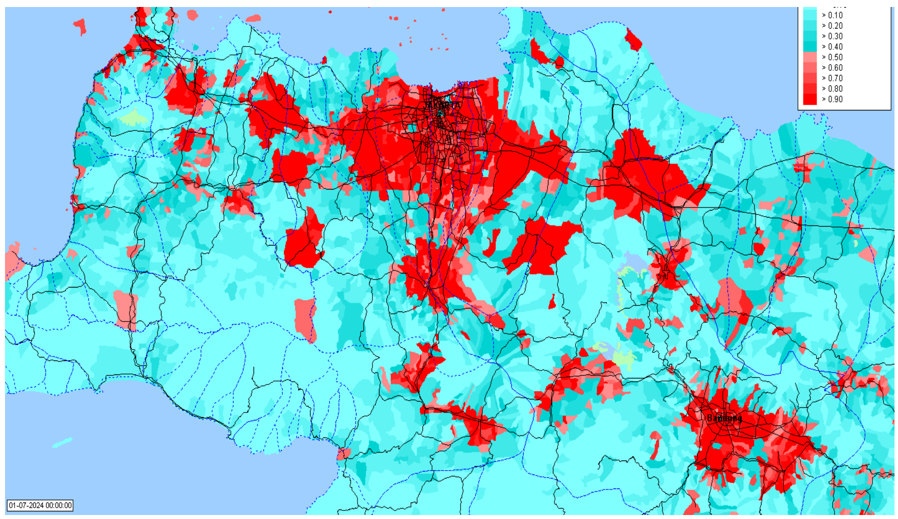


Figure7: Greater Jakarta in 2025 (forecasted with JSM) based on a network development strategy.

Further it should be emphasized that this paper does not claim that the network city concept is the best approach for the Greater Jakarta region. It only wants to make the case that strategic planning is urgently needed for this region. A planning framework and culture is needed in which alternative spatial plans are designed and evaluated on their consequences. The use of quantitative information from different sectors and land-use simulation tools can help to make such exercise realistic as it makes the choices and trade-off's explicit.

4. SPATIAL DEVELOPMENT AND MOBILITY

It is widely accepted that land-use, economic and transport developments are closely related: land use and economic changes have impacts on transport demand and the performance of the transportation network and, vice versa, changes in the transport system affect the settlement and performance of residents and firms (Zondag, 2007). The interactions exist at an national or Island level, where transport is essential for economic development as it creates scale advantages and competitive prices for products, as well as at a regional level where transport efficiency affects the regional economy.

Regarding the interaction with land-use an often used diagram to illustrate the mutual interactions between land-use and transport is the 'land-use and transport feedback cycle' by Wegener (1999) (abbreviated version in Figure 8).

The relationships in this diagram can be briefly described as follows:

- The distribution of *land uses*, such as residential, industrial or commercial, over the urban area determines the location of human activities such as living, working, shopping, education or leisure.
- The distribution of human *activities* in space requires spatial interactions or trips in the *transport system* to overcome the distance between the locations of activities.
- The distribution of infrastructure in the transport system creates opportunities for spatial interactions and can be measured as *accessibility*.
- The distribution of *accessibility* in space co-determines location decisions and so result in changes of the *land-use* system

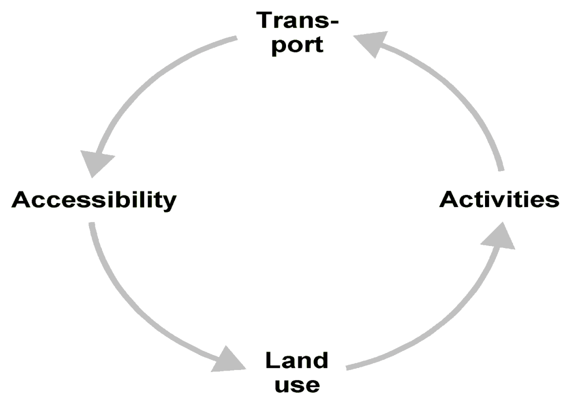


Figure 8: Land-use and transport feedback cycle

The impacts of transport developments on land-use are especially strong for developing countries like Indonesia as the land-use dynamics are high and the relative difference in accessibility resulting from an investment is large. For example, the structuring land-use effects of a new road is likely to be larger in an area with a sparse road network than in an area with a dense road network. Land-use changes that can be expected as a result of infrastructure development in Indonesia are sub-urban land development are corridor developments along the (line) infrastructure. These spatial developments need to be managed by spatial planning to protect the interest of other sectors like agriculture, sawah area, forestry, water, etc.

The map in Figure 9 illustrates a calculated projection of the corridor development along the planned Java toll-way. A supporting spatial policy will be needed to protect for example sawah and the sensitive catchments of lakes along the alignment of the road. The map in Figure 10 presents the impact of such water related zoning to protect an important lake upstream of Semarang.

As described in section 2 the overwhelming trend in urban land use in Indonesia is sub-urbanization. This issue will only become more important as the growth potential for further (sub-)urbanization in Indonesia is very large due to currently low car ownership levels and poor road infrastructure conditions. The result of a large scale sub-urbanization on Java will be a strong increase in urban land coverage (as suburban densities are low), associated lost in available land for other functions, and a high increase in car based transport and related congestion problems. To mitigate or avoid this development a controlled spatial development, as suggested in previous section, complemented by a supporting transport strategy is needed to create a sustainable urban transport system. In the case of the urban network city a complementary public transport system need to be developed to serve these high density nodes.

Figure 9: Illustration of corridor development along he Java Toll road (projection with JSM)

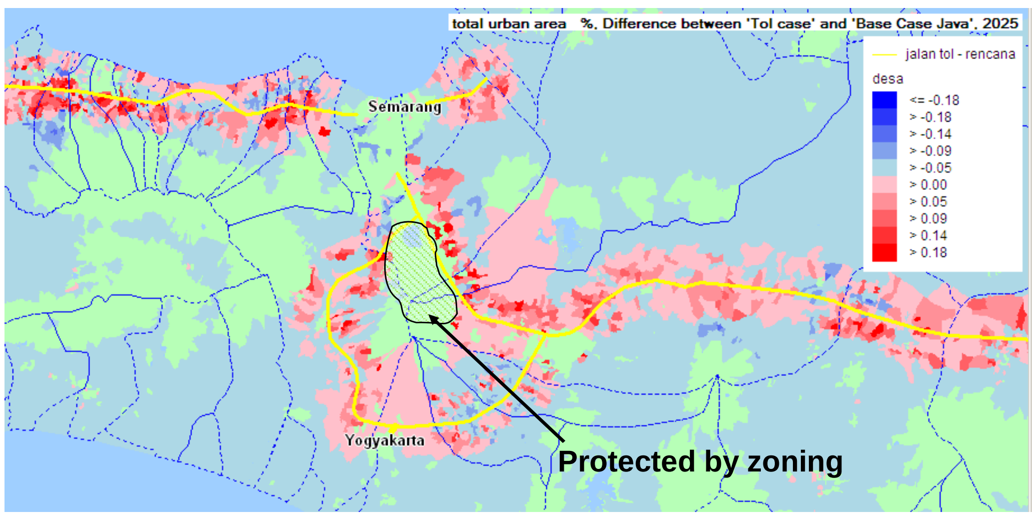


Figure 10: Illustration of the result of water related protection on the projected (JSM) corridor development along he Java Toll road

It is important that transport gets integrated in the urban development plan from the start. Ignoring this aspect in the process, and adding or implementing a transport strategy once the development has been realized, is much more complicated. For example to implement rail service it is needed that land has been reserved for construction of the track, urban densities should be high enough to make a service financially feasible and a nodal structure should be created with activities around the station locations.

The strong relationship between spatial developments and mobility in Indonesia justifies a spatial plan which, at the Island as well as at the regional level, addresses this aspect as an integrated part of the plan. Important issues to address are:

- Spatial planning influences the location of urban development and therefore transport demand
- The spatial plan needs to be balanced with transport strategy to take advantage of economic potential of a good accessibility (e.g. office/mall development at station locations)
- The large infrastructure projects cause land-use changes – the spatial plan should recognize this and protect areas if needed

In practice this means that transports experts and - institutions need to be involved in drafting the spatial plans and vice versa that spatial planning experts are involved in the design and evaluation of transport plans.

5. AGRICULTURE

Projection of land-use for 2025 (Figure 11) presents a strongly reduced (13%) area of irrigated agriculture. Such land-use change will be particularly strong around the larger cities. This change will have consequences for self-sufficiency in production such as rice; Figure 12

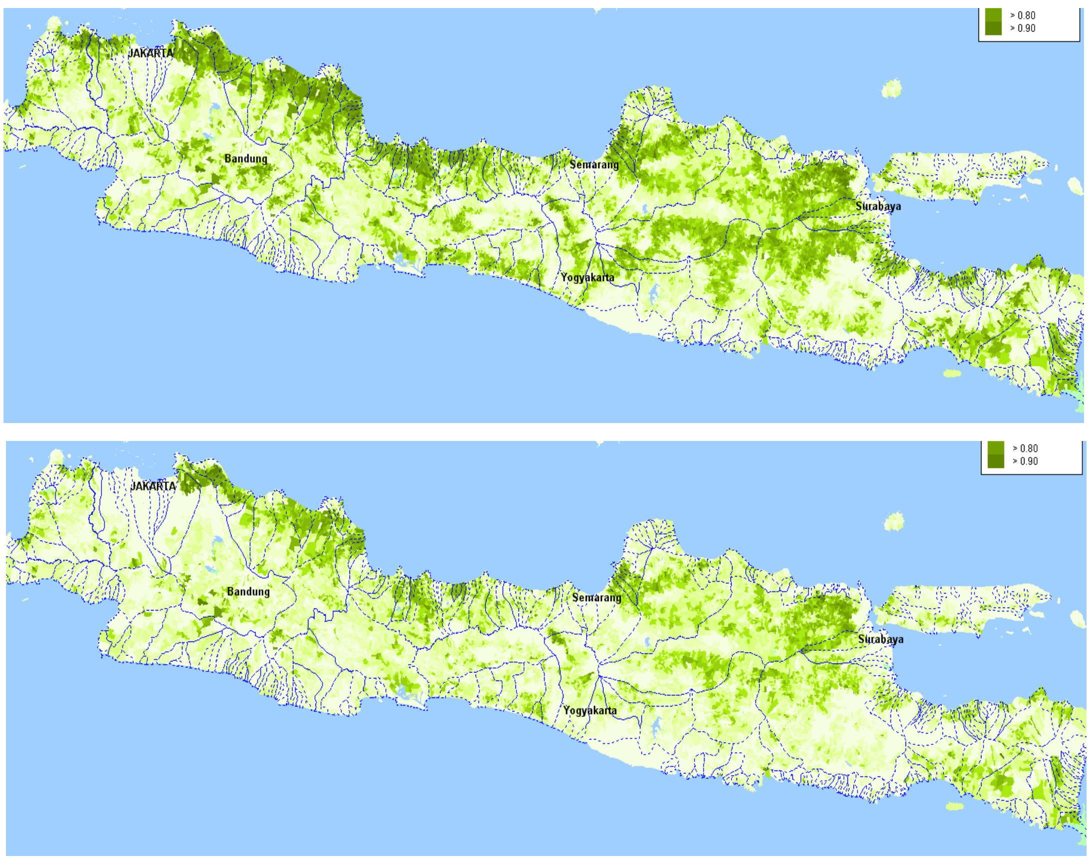


Figure 11: Loss of irrigated area, maps presenting irrigated area in 2000 and 2025 (projection with JSM)

presents a projection of self-sufficiency for rice on Java taking into account an increasing demand (population), a decreasing production area and a modest increase in yield.

An ongoing trend in agriculture production, triggered by a growing urban market is a transition from a traditional practice focused on rice, towards commercial cropping focusing on vegetables and fruits, serving the urban markets.
Irrigation water supply is by far the largest water user on Java; irrigated rice cultivation is an intensive water user (volume about 5 times larger than for vegetables).

The combination of a reduced area and an anticipated accelerated change in cropping pattern in response to the urban market, together with a strongly increasing urban water demand, will drastically change water supply and water management. Even an overall reduction in bulk water demand may result; the strong seasonality of water supply versus the continuous demand in an urban setting will require more emphasis on storage and control (throughout the dry season)
An adequate projection of demand (agriculture, urban) will be essential in a pro-active planning of water resources on Java; an integrated and detailed projection, such as provided by JSM, is then essential.

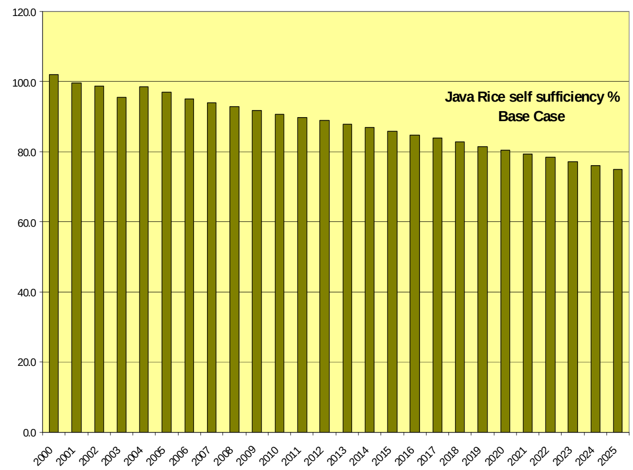


Figure 12: Projected self-sufficiency of Java in rice production (2000-25

6. WATER - CONSERVATION

Strong land-use changes have taken place in recent years in river basins on Java, with strong negative impacts on the performance of water systems. Projections of land-use for the period up to 2025 show a continued strong change in land-use. It has become obvious that the performance of water systems, is very sensitive to land-use change and thus has become strongly dependant on spatial development; an integrated planning of space & water has become a necessity.

Intensifying land-use will increasingly require to balance different interests in development, requiring for example to make trade-offs between conflicting interests in water- and land-use development. Such situation has for example emerged in the B. Solo basin: an intensified land-use potentially causes increased erosion and has a negative effect on the run-off pattern in the river basin (higher peaks, lower low flow). A desired balance between those interests will need to be established based on information on the socio-economic benefits of opening up new areas or considering new land-use functions, the potential negative impact on water resources, and the cost of possible remedial measures to control negative effects. Based on such information and identifying/ranking of the most sensitive areas a conservation zoning is needed (designated areas with associated regulation) which can be used by the authorities to implement the desired overall resource management policy in the basin (balancing local interest versus overall interest)

The primary objective of spatial planning is to

- optimize land-use to create the maximum value for society, in combination with
- protection/conservation of vulnerable functions in certain areas by imposing regulations

Two main components can then be differentiated in the approach to deal with those objectives

a) water should become one of the guiding principles in spatial planning in order to influence spatial planning such that the negative impacts of future land-use changes are minimized as much as possible, and potentials become (fully) realized; favorable patterns of spatial development can be identified based on a mapping of specific water- and space attributes

b) specification of water related zoning (erosion, runoff control, ..) to conserve/maintain/re-install favorable water resources characteristics. Zoning forms the main instrument to control ongoing – and prevent future catchment degradation.

Component a) requires a facility to project the effects of alternative spatial plans. A mapping of spatially distributed water related attributes such as, emissions, flood damages, remaining forest, sensitivity to sea-level rise, etc., linked with the projection of settlement/economic activities, forms a main input to pro-active planning of land-use. The post-processor of JSM (see Section 2) can be further developed to provide such planning tool.
A particular concern for environmental sustainability is the preservation of sufficient forest area in each of the different catchments (DAS). The New Spatial Law specifies a minimum forest

Figure 13: Projected land fraction forest by DAS in 2025

area of 30% as a minimum to maintain an "ecologically healthy" catchment. Figure 13 presents a projection for 2025 of percentage forest area for the different DAS on Java; only a few of the DAS satisfy this requirement. A careful balancing of environmental versus economic interests will be necessary to establish a realistic/acceptable forest conservation for each DAS.

The contribution of component b) of the approach to optimization of land-use comprises minimization of the (potential) negative effects (vulnerabilities) of settlement by zoning and associated regulation; this forms main instrument in spatial policy making. This covers two main purposes: protection of interests in the different sectors and harmonization (see Section 8) of the use of space by the different sectors.
There exist many different types of zoning, for example for water

- Flood zoning
- zoning for emission control
- Watershed conservation (e.g. to prevent erosion)
- Groundwater protection, etc

The definition of the optimal zone and methodology for its derivation will be different for each of those aspects. In the case of Flood zoning the optimum can be defined as the zone that provides the best reduction of flood damages in comparison to the costs of implementing the zoning and flood damage control measures. In the case of emission management the optimum

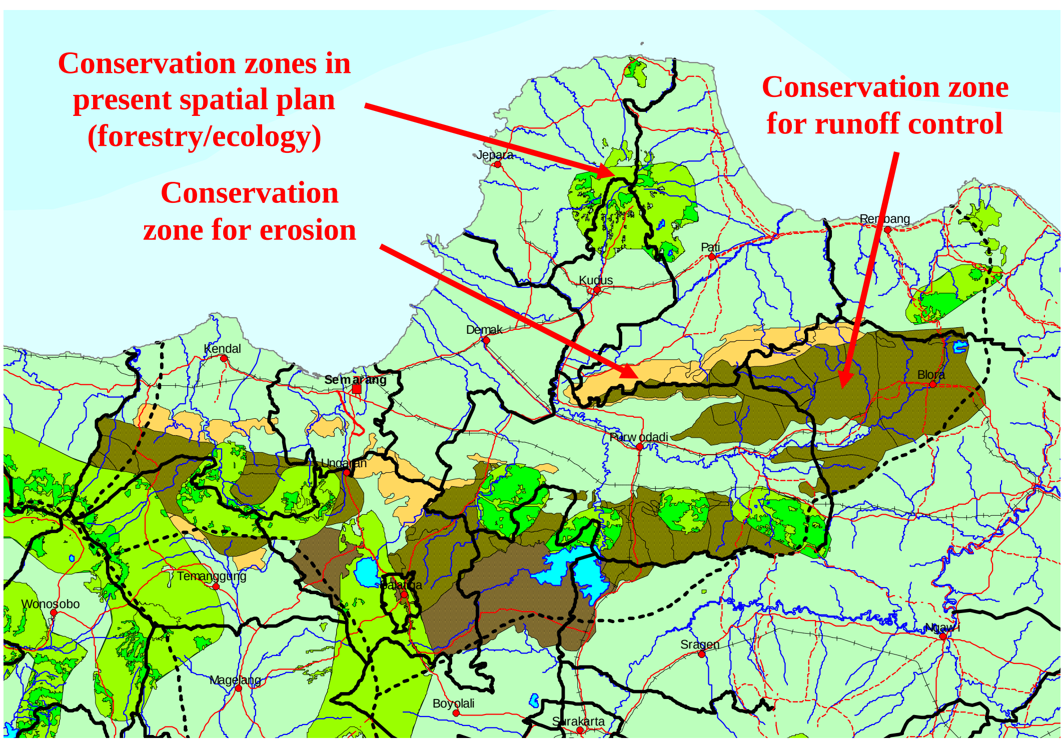


Figure 14: Water related conservation for the Jratunseluna basin in addition to conservation for forestry/ecology (draft spatial plan)

zoning will usually also be based on non-monetary values, for example the minimization of the impacts on the ecological state of the water-system. In the case of watershed protection a mixture of monetary and ecological indicators may be needed. Different spatial levels need to be differentiated for zoning policies. For example for zoning for the water sector usually river basin wide interests and interactions will need to be considered; this may be complemented at the local level with more detailed/additional zoning.

In the "Integrated planning of Space & Water" project an indicative zoning analysis has been done for conservation of runoff (peak flow/low flow – main factor influencing flooding and drought) and erosion for catchments in the Jratunseluna river basin. The necessary information about the water system and area has been derived from the study "Basin Water Resources Planning project (BWRP)- Jratunseluna basin plan". The runoff and erosion conservation zoning for the Jratunseluna basin has been developed based on the following characteristics:

- Water sector specific knowledge is needed to draw protection zones for erosion or run off conservation
- An incremental approach has been used – diminishing rate of return
- A CBA method has been used to evaluate zoning as a policy option
- Figure 2 illustrates the zones which were delineated for erosion – and runoff control; this was based on readily available data and an evaluation of impacts.

7. INSTITUTIONAL AND ORGANIZATIONAL CHALLENGES

Spatial planning has a coordinating role (see Figure 5) with respect to the different sectors; furthermore a coordination is necessary between different levels of government. The New Spatial Law explicitly recognizes this multi-sector multi-level coordination role for spatial planning.

Besides regulations following directly from the New Law there will be a strong need for voluntary agreement between different parties to address problems/challenges in a coordinated effort, for example by producing jointly recognized policy documents. An example of such coordination/cooperation is the harmonization between water related interests required to implement the more complex WRM measures/projects such as for example conservation.

To address conservation issues a program of harmonization covering the fields of Water Management, Spatial Planning, and Environmental protection and Nature Conservation will be required. The cooperation can comprise representation in joint water boards, joint steering and working groups to work out proposals, the publication of joint commitments in plans that are of a strategic or operational nature. Part of such cooperation may be given a legal status in order to ensure sufficient commitment and sufficient attention to updating at regular time intervals

As an example Figure 15 presents such process of harmonization as it has been implemented in The Netherlands. The harmonization covers the fields of Water Management, Environmental protection, Spatial planning and Nature Conservation. The involvement of different levels of Government is indicated. The cooperation comprises representation in joint water boards, joint steering and working groups to work out proposals, and the publication of joint commitments in plans, which are of a strategic or operational nature.

Although much of the cooperation has taken place on a voluntary (efficiency) basis the whole set-up has been given a legal status in order to ensure sufficient attention to updating the plans at regular time intervals.

Strategic information on potentials, options and interrelationships is important to support the harmonization process. An important step to generate this information has been set with the implementation of the river basin planning and management program. A further important step will be to (fully) implement pro-active spatial planning.

8. CONCLUSIONS - OBSERVATIONS

The growth in urban land-use on Java is projected at a 70% increase in urban land by 2025; this will result in a built-up area increasing from 18% at present to a very high 30% in 2025; this growth is caused by population growth and other factors such as declining household sizes, increasing welfare and suburbanization. In combination with existing problems it is clear that a continuation of a largely unplanned and unrestricted spatial development will have severe consequences for the physical - and living conditions on Java.

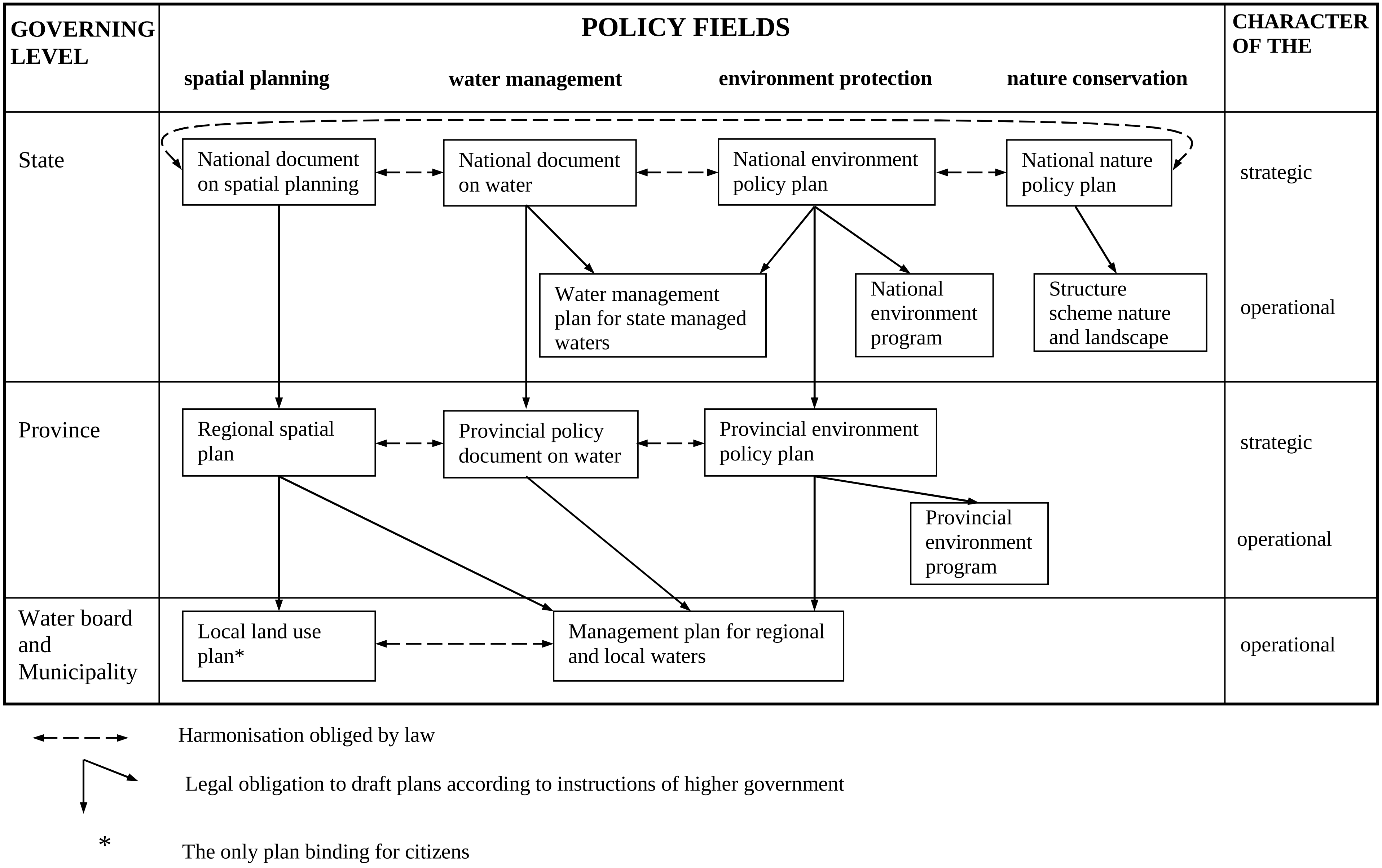
An extensive pro-active planning comprising a combination of resource management, regional planning, infrastructure development, and protection through zoning and regulation will necessary to guide the developments towards a maximization of potentials and minimization of adverse impacts. It is concluded that a flexible tool to project future land-use will be essential for this optimization.

The need for a more pro-active planning has been recognized in the New Spatial Planning Law (2007), and the challenge is now on the implementation of an efficient spatial planning framework capable of protecting the interests of the 3 p’s (people, planet and profit). The Java Spatial model as described in this paper, which simulates urban development and associated land-use changes, can be an important supporting instrument for spatial planning, based on:

- production of spatial projections: the modeling translates the socio-economic and demographic scenarios into detailed spatial projections which makes it possible to assess these future developments on their consequences and need for policy intervention (e.g. see map illustrating loss of irrigated area due to urbanization);
- calculation of the impacts of alternative land-use policies (such as zoning or urban densification strategies) and support to the policy maker with information on the type and size of choices which need to be made.

A review of some important planning sectors reveals the following priority aspects for analysis and policy making

- urban development: the strong urban growth will require a development concept which addresses employment, mobility and water management problems. In spite of the recent (uncontrolled) growth, a network city concept may still be a viable concept
- mobility: land-use – economy – transport developments are strongly related; in view of the strong land-use changes and expected economic growth and transition to more non-agriculture activities, a very dynamic situation for mobility can be further expected; a sufficient accessibility at the inner city and inter-regional level will be needed; the way for the strongly growing Jabotabek region to create a sustainable urban transport system may be to implement a controlled spatial development comlemented with a supporting transport strategy


GOVERNING LEVEL
POLICY FIELDS
CHARACTER OF THE
spatial planning
water management
environment protection
nature conservation
State
National document on spatial planning
National document on water
National environment policy plan
National nature policy plan
strategic
Water management plan for state managed waters
National environment program
Structure scheme nature and landscape
operational
Province
Regional spatial plan
Provincial policy document on water
Provincial environment policy plan
strategic
Provincial environment program
operational
Water board and Municipality
Local land use plan*
Management plan for regional and local waters
operational
Harmonisation obliged by law
Legal obligation to draft plans according to instructions of higher government
*
The only plan binding for citizens

- agriculture : a substantial reduction of irrigated area is projected together with a change in cropping pattern in response to a strongly growing urban market. This will have strong influences on water management and will require a re-definition of agricultural production targets and – support programs
- water – conservation: an adequate projection of water demands will be critical in view of the strong changes in demand (irrigation, urban) ; the performance of water systems is highly sensitive to a changing (intensifying) land-use; sustainability of water systems is therefore a major issue; there is therefore a need to incorporate water as a guiding principle in spatial planning; to support such planning there is a need for spatial distributed attribute maps (emissions, flood damage, ….). Establishing zoning will be crucial to help optimize land-use.

In addition to sector policies adopting the spatial context, a harmonization between sector policies will be required to adequately address complex policy fields such as conservation.

In this paper a sketch has been given of the role of spatial modeling of land-use as part of preparation of a spatial plan and input to sectoral analysis.
The combination of scarce land resources and high land demand on Java makes it clear that the political choices that need to be made regarding the spatial planning of Java will not be easy as they will affect for example agricultural production, flooding, ecological conditions, urban living conditions, economic settlement conditions, etc. A structured analytical approach, consisting of an improved data collection, data processing, simulation and visualization of land-use changes and calculation of policy indicators, can help to establish transparent trade-offs.

10. REFERENCES

Ministry of Public Works (MPW), DGWRD , "*Basin Water Resources Planning project (BWRP)- Jratunseluna basin plan"*, Semarang, 1999
MPW, DGWRD, "*BWRMP project - Pilot spatial planning model*", Jakarta, 2003
MPW, DG Spatial Planning, "*Integrated planning for space and water*", TUD/Demis/WL, Jakarta, 2007 (ongoing)
Sjarief R., Verhaeghe R.J., *Multi-sector planning for water resources development*, ICID, 1998
Suyanto A., Verhaeghe R.J., "*Optimal water allocation planning for multiple water use sectors and distributed demands*", ICID, 1998
Verhaeghe R.J., Sjarief R., Zondag B., "*Integrated supply-demand modeling for regional development planning (Contribution of infrastructure planning to overall regional planning)"*, Int. Conf. on Regional Development Planning: Theory and Practice",IRSA-USAID, Jakarta, oct 1998
Wegener, M., Fürst, F. (1999), *Land-Use Transport Interaction: State of the Art,* IRPUD, Dortmund
Zondag et al., *Toepassen van TIGRIS XL binnen de studie 'Nederland later (Application of TIGRIS XL in projection for the Netherlands)*'. Report for Netherlands Environmental Assessment Agency, Significance, Leiden, 2007.
Zondag, B (2007), *Joint modeling of land-use, transport and economy,* PhD Dissertation Delft University of Technology