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Welang River Basin Flood Management and Master Plan

Executive Summary

Netherlands Enterprise Agency-Partners for Water
Water Resource Department of East Java Provincial Government

27 January 2022

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INTRODUCTION

The Welang River Basin Flood Management and Master Plan project was executed under the cooperation between the Water Resource Department (PU-SDA) of the Provincial Government of East Java and the Netherlands Ministry of Infrastructure and Water Management. The project was implemented under the Partners for Water Program, a program managed by the Netherlands Enterprise Agency (RVO), part of the Netherlands Ministry of Economic Affairs and Climate.

The Welang project is part of the strategic cooperation between the Netherlands and the Ministry of Public Works and Housing of Indonesia and the Province of East Java, under the MoU Water. Two other projects implemented in 2020-2022 are also part of this cooperation: the Welang Healthy River Challenge and the Welang River Basin Academy. Discussions for new cooperation projects in this area are ongoing.

The Welang project supports PU-SDA in developing intervention and management strategies for both the entire river basin and for urgent issues, i.e. flood mitigation in the Pasuruan – Kraton area. The project is subdivided in five tasks, three of them leading to tangible deliverables: a baseline study, an Integrated River Basin Management Plan (IRBMP) and implementation plans for two potential interventions for flood mitigation. The two remaining tasks focus on interactive community and stakeholder involvement, training and capacity building.

This Executive Summary presents, in a condensed format, the main results of the project. Comprehensive reporting is in the form of 5 documents covering the 5 project components. All reports and relevant data have been handed over to PU-SDA.

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MAIN FINDINGS AND RECOMMENDATIONS

Flooding is increasingly a problem in the Welang catchment. Flooding mostly occurs in the downstream section of Welang river in and around the Kraton district, but also affects settlements in the midstream sections from Lawang to Sidogiri. Floods are limited in depth, area impact and duration.

The Welang study determined that in the Kraton district floods are of combined fluvial (river) and pluvial (rainfed) origin, while in the other areas they are mostly pluvial in origin.

The study provides strong evidence that the recent increase in flooding is mainly a result of man-induced changes in the catchment: rapid urbanisation and industrialisation is taking place throughout the river basin.

The most important pillar of water management in the Welang river basin should be sustainable spatial, economic and agricultural development policies in which soil and water conservation have a key role. To be successful, these sustainability-oriented policies should be applied on all government levels.

Economic development has resulted in a strong urbanisation process throughout the catchment with expanded housing areas and large factory complexes along the main transport corridors with toll roads, and in the vicinity of (old) irrigation and drainage channels. This urbanization process is not accompanied by sufficient expansion of the stormwater drainage systems. Another process is the expansion of intensive agriculture further up the steep mountain slopes of the catchment. Fields are cultivated with crops (often irrigated by sprinklers), and little forest is remaining, resulting in higher run-off and soil erosion. The changes in land use are managed insufficiently (spatial plans mostly follow developments), and little to no soil and water conservation requirements are in place (e.g., vegetation belts, terracing, water retention structures).

The changes in land use in the river basin cause higher peak discharges during the rainy season, with much higher and flash-flood type river discharge, with flooding as a consequence.

Another effect is that there is less infiltration and recharge of groundwater. Furthermore, during the last decades the demand for groundwater for water supply in industrial zones, urban areas and for agricultural purposes has grown significantly. As a consequence of these combined processes, groundwater tables in the mid-stream and upstream areas have significantly lowered, leading to reduced discharges from springs and lower baseflows in the rivers especially during the dry season.

Climate change will lead to less infiltration and therefore result in lower baseflows and groundwater tables.

For the next 30 to 50 years, climate change may lead to a shorter rainy season with more rainy days. Climate change may lead to less infiltration and therefore lower groundwater tables and baseflows, especially during the dry season. It is not expected that climate change in the medium term will lead to higher rainfall intensities or changes in the average annual rainfall. Flood conditions are therefore not (significantly) affected by climate change.

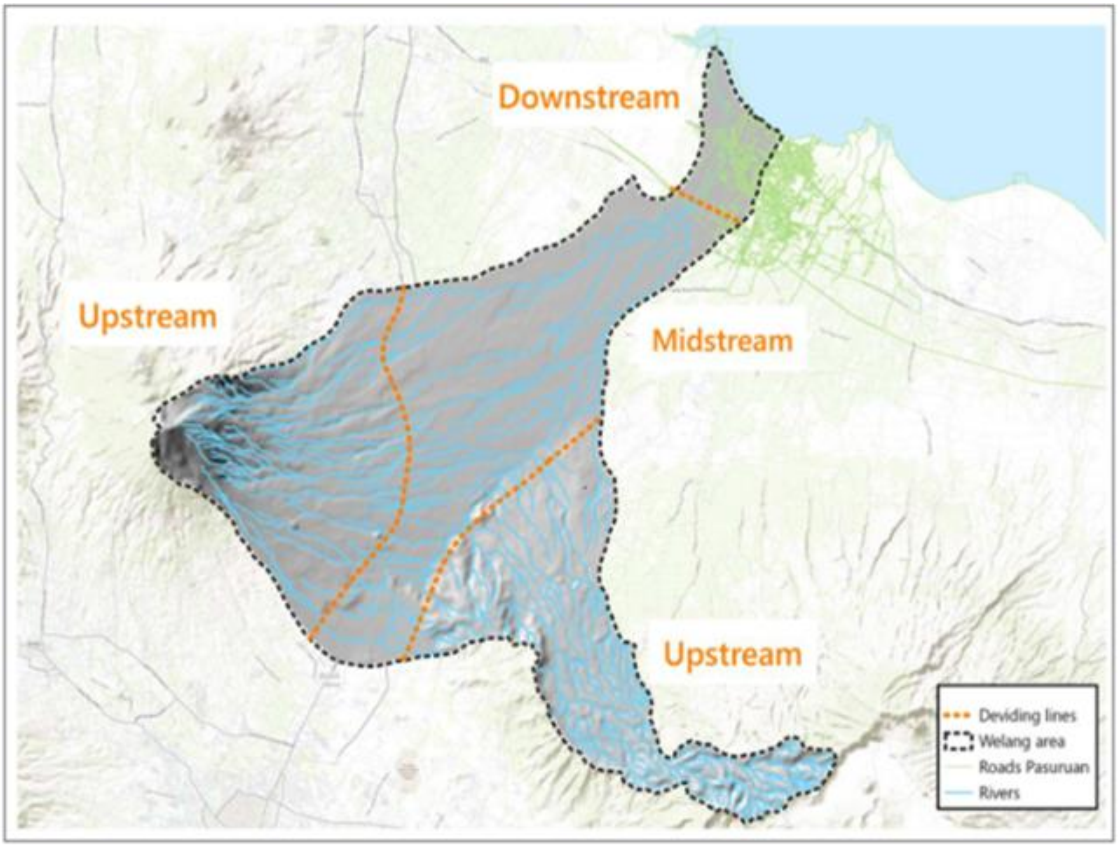
In the Welang river basin, flood management is mostly limited to post-disaster recovery and 'hard engineering solutions' like embankments, dams and revetments.

Although various government agencies have flood mitigation plans, in practice little coordinated and effective prevention efforts are developed or implemented. Maintenance of existing flood protection infrastructure (e.g., maintenance dredging of rivers, cleaning of roadside drains, etc.) is limited and not effective. A lot of waste ends up in the river and this contributes to generally poor appreciation of the river system as an important and vulnerable source for fresh water and in support of community livelihoods.

The recently implemented improvement and heightening of the river embankments have positive effects in the short-term, but may not be sufficient in the longer term.

To immediately address the short-term fluvial flood risks in the downstream Welang river section, additional protection measures need to be taken that lower peak water levels in and around Kraton (e.g., dredging, creation of a diversion channel). Fluvial flood risks can be further lowered by aligning additional structural measures and maintenance efforts by the various local and provincial departments involved, especially in the lower upstream and midstream parts of the catchment. These potential interventions for flood mitigation in the downstream section of Welang river are not yet ready for implementation. A more detailed feasibility analysis still has to be done.

Figure 1 The Welang river basin with three sections



Across the river basin, non-structural measures (soil and water conservation, applying an integrated water management approach) have to be developed, agreed and implemented.

Measures need to be taken in the upstream reach to reduce run-off: terracing and the deployment of gully plugs in addition to the introduction of water sensitive agriculture practices. Land development on steep slopes should be restricted altogether to reduce run-off and prevent excessive soil erosion. Spatial plans need to be drafted based on realistic estimates and the hydrological impacts should be evaluated.

Overall, these measures require strong coordination and collaboration between the regional, provincial, and central governments and different sectoral agencies (i.e. water resources, groundwater resources management, agriculture, forestry, spatial planning, etc.).

The developed IRBM Plan is a very good start but lacks priority setting and agreed upon implementation arrangements including budgeting.

Both the existing plans and the newly formulated IRBM plan (this study) do not go beyond rather general and loosely prescriptive measures. These are obviously not sufficient to mitigate the long-term negative developments on landscape scale in the river basin.

One of the aims of the Welang study was to identify and consider possible follow up interventions, namely additional studies, building of structures, or non-structural activities. At the end of the document three options are briefly presented:

1. A joint framework for a sustainable water future in the Welang river basin.
2. Understanding local floods through monitoring and drainage plans, training of staff.
3. Consolidating the flood safety at Pasuruan through additional hydraulic interventions.

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THE WELANG RIVER BASIN

The Welang river basin is situated in East Java, in between the cities of Pasuruan and Malang and two major volcanic complexes: the Bromo-Tengger highlands (up to 2,758m high) and the Arjuna volcano (3,150m high). The Welang river drains into the Madura Strait in the Porong river estuary. The size of the Welang catchment is about 518km^2. The river is narrow, with an incised river valley for most of its course, and with a maximum width of 25m near the river mouth.

The upstream sections of the catchment consist of steep hills. The Arjuna slopes are largely covered with forests and scattered villages. This area is important for tourism and recreation and many new facilities and infrastructure is being built. Land use on the slopes around Bromo consists of a mix of forests, agro-forestry and agriculture. The midstream section is characterized by an undulating, northward sloping topography dominated by irrigated agriculture and numerous settlements. The downstream section is mostly flat with a maximum elevation of 10m+MSL and is densely populated. Rice paddy fields are gradually being replaced by residential areas and industrial estates. Toll roads traverse the area west – east and north-south and there is a rail network.

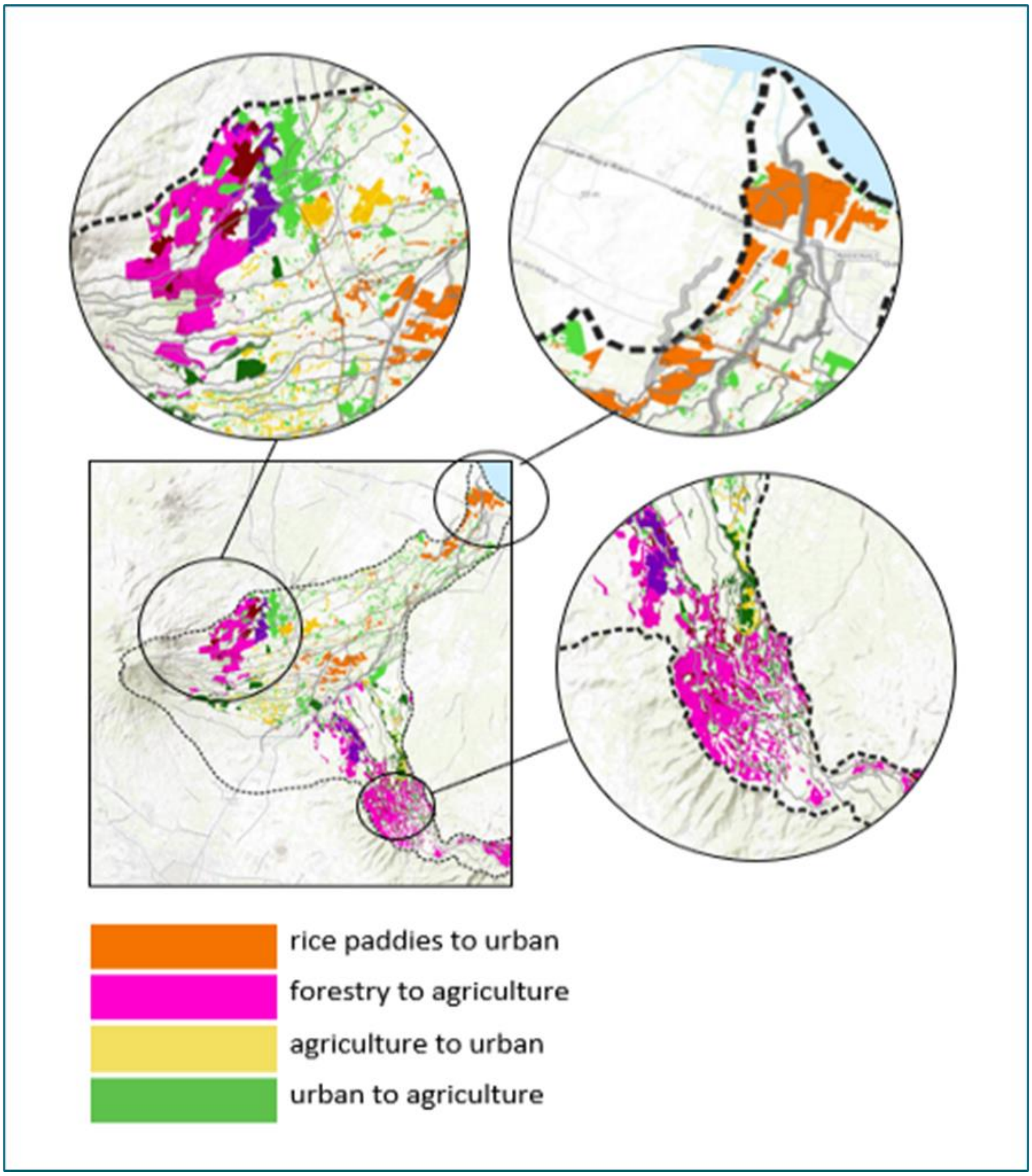
Figure 2 Typical landscapes in the downstream, midstream and upstream section

Changes in the river basin

The upstream and downstream subregions are transforming rapidly: the downstream part is becoming fully urbanized and industrialized. This urbanization and industrialisation is also taking shape on the boundary between mid-stream and upstream (along a newly built toll-road). The slopes of the Arjuna volcano are becoming recreational areas, while the slopes of the Bromo are transitioning from traditional, extensive agro-forestry systems to more intensive, commercial agriculture.

The changes are clearly visible when the spatial plan of 2010 is compared with the one of 2020. Large parts of the land in the downstream area are destined for urbanization, while large areas in the upstream sections are transformed from forestry into agriculture, or from agriculture to urban areas (Figures 3 and 4).

Figure 3 The changes in the land use plans 2010 - 2020 are an indication of a changing landscape.

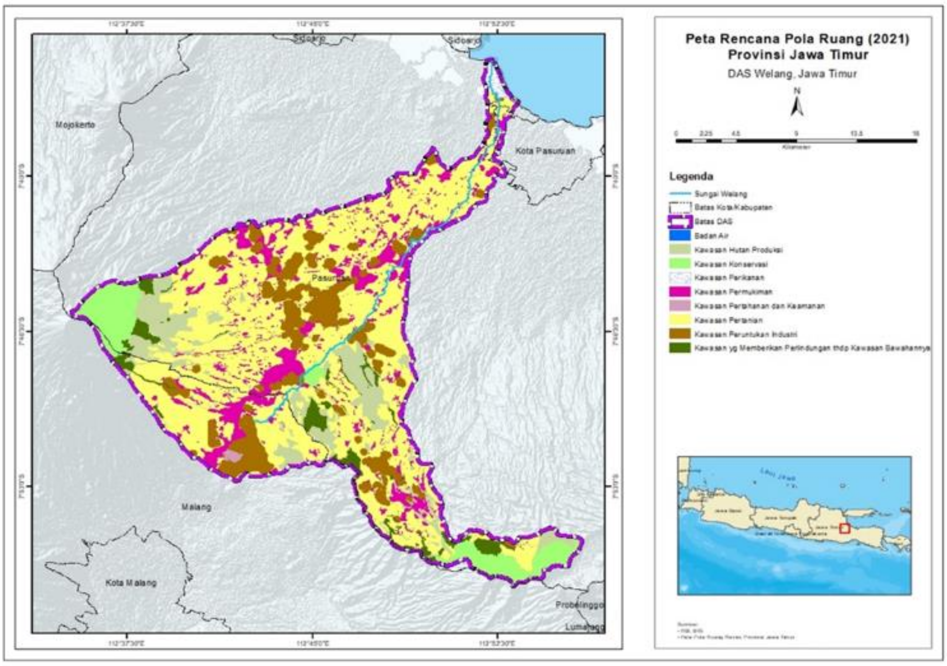


The most recent land use plan (2021) shows even more land assigned for residential and industrial functions, as can be seen in the provincial land use plan from 2021 below, Figure 4.

Impact of land use change: more floods, more erosion, sedimentation and groundwater depletion.

The changes in land use are having a major impact on floods, droughts, soil erosion and sedimentation. The agriculture on the steep slopes will sharply increase the erosion and sedimentation rates (of soil materials in the river bed), while mid- and upstream urbanisation and industrialisation will increase the run-off of water, leading to floods downstream. Groundwater, once plentiful in mid and upstream regions, on the other hand, is overexploited and locally already depleted by industrial and residential use[1].

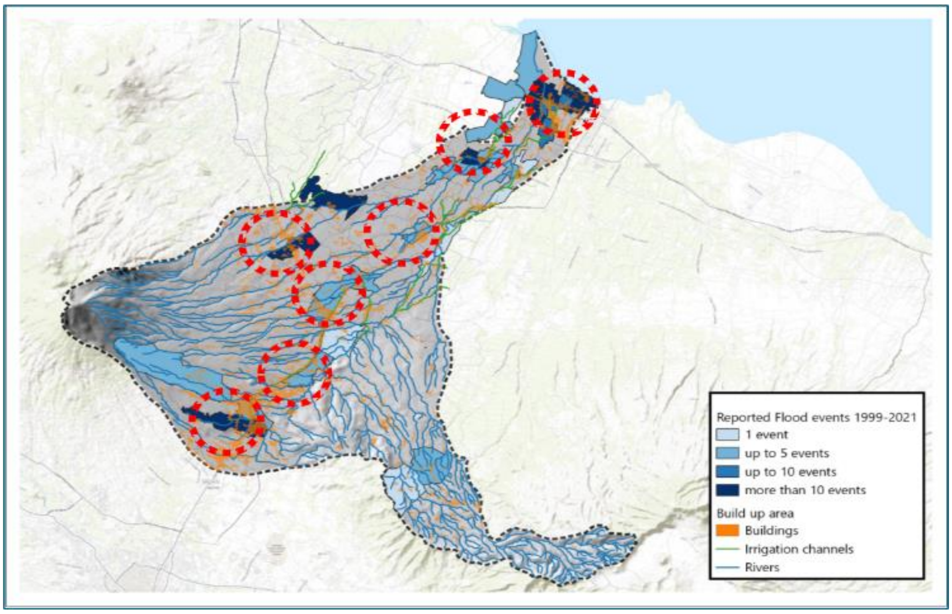
Figure 4 Land use plan for the Welang river basin, according to the Provincial land use plan 2021: purple indicates residential areas, while brown indicates industrial areas. Yellow indicates agriculture, while green is forest/protected areas.



Most areas that are vulnerable to and experienced flooding already are located in the downstream areas (near the so-called Kraton area). The map below (Figure 5) shows the reported flood events between 1999 and 2021. It is clear that the flood frequencies increase towards the downstream section.

[1] The Welang project mainly focused on flood management, but a quick-scan analysis of the groundwater system was included.

Figure 5 Reported flood events 1999-2010 and (in red circles) the areas prone to pluvial flooding.



In the project the impact of land use changes on the floods was modelled, using the WFLOW-model. The model showed that in the period 2013-2021, the flood peaks in the downstream river section (in the Kraton area) increased by 10% (20 cm higher), another 10% increase is expected in the coming decade (20-50 cm higher, depending on the location).

However, it should be noted that many floods are caused by a combination of intensive rainfall and poor internal drainage of urban areas (pluvial flooding) and not so much by flood waters from rivers (fluvial flooding). As the urbanisation is also high in the downstream region, many pluvial floods are also located in this area. Figure 5 shows the locations where pluvial flooding is likely to occur.

In most of the mid- and downstream areas, the water infrastructure system (canals, weirs, sluices, etc.) was originally designed for irrigation purposes: the system was designed for provide water to paddy fields for rice production, not to drain water from urban areas or divert flood waters. Size and design of these canals therefore may not be optimal for drainage purposes and, although no detailed survey was done to this specific aspect, the project hydrologists suspect that this inadequate design contributes to pluvial flooding. Also decreased capacity and partial blockage of drains with floating waste and due to siltation is a contributing factor.

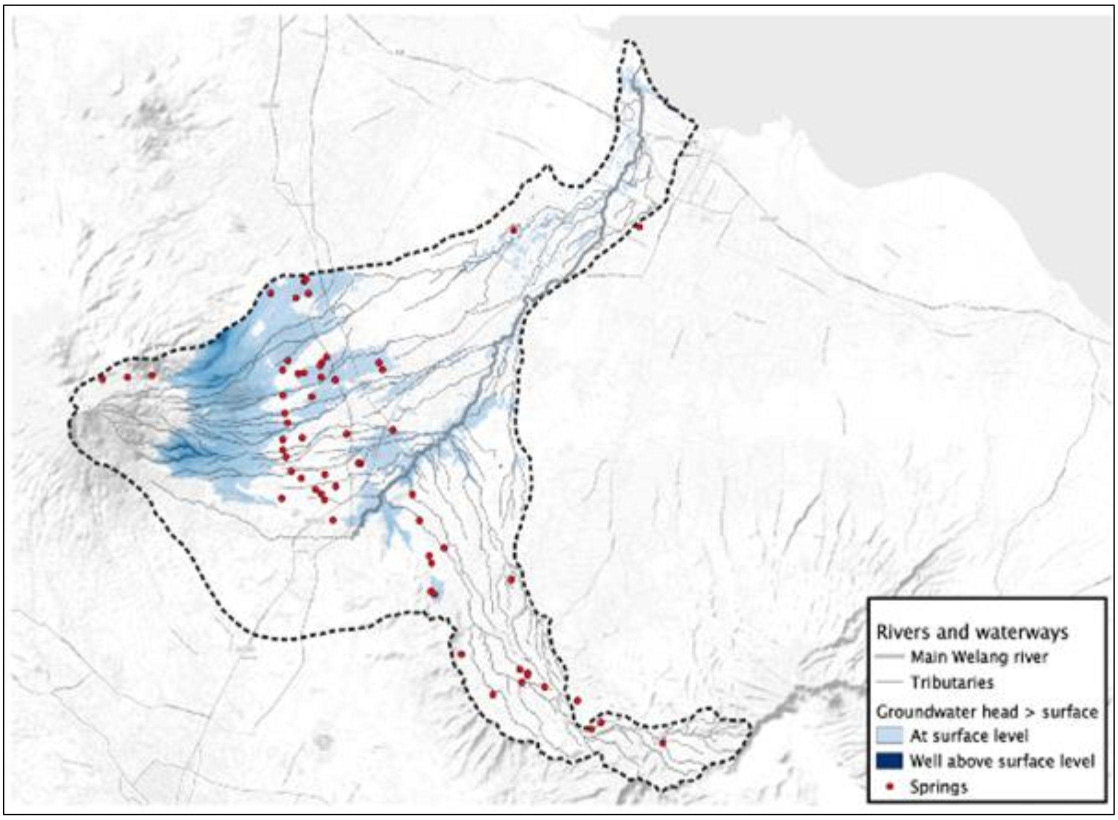
In addition to more floodwaters flowing downstream faster, due to reduced infiltration and more intensive rainfall, other factors also contribute to the floods. One of the factors is the high rate of sedimentation in the downstream section of the Welang river. Comparing two surveys (2012 and 2017) showed that the sedimentation rate is almost 10 centimetres per year. Sedimentation changes the profile of the river, reducing the discharge capacity (which leads to higher flood peaks). Finally, over time, river banks became populated and the floodplain was reduced, which also affects river flow during flood events .
In 2020-2021, the river embankments around Kraton were heightened and the risk of flooding in this area has diminished. However, with the ongoing transition in land use and the sedimentation of the Welang, the flood safety may not be guaranteed for the future.

Figure 6 Newly constructed and raised (1.5 m) concrete river embankment near Kraton Bridge.

Groundwater resources

Generally, groundwater resources are abundant on the lower volcanic slopes on Java, with large aquifers and numerous large springs (for instance the Umbulan spring on the northern slopes of Bromo complex). However, decades of groundwater extraction and major increase in extraction volumes poses a threat to long-term sustainability of the groundwater flows. For sure, in the river basin the depletion of groundwater reserves by massive groundwater extraction (for domestic, industrial and irrigation purposes) and decreasing groundwater recharge (due to deforestation and land use change), forms a less visible, but equally challenging issue. In the Welang river basin, groundwater surfaces as numerous springs in the transition between the upstream and the mid-stream areas, and this water is used by households and as irrigation water. In the last decade, many springs are drying up, posing difficulties for communities and farmers who have benefitted from these cheap and good quality water supplies.

Figure 7 Springs in the river basin.



In the Welang project, the historical and future recharge of the groundwater was simulated, using two models (WFLOW and MODFLOW). Although detailed information (geology, complete historical groundwater use data) was scarce in order to make detailed assessments, it becomes clear that groundwater levels are dropping significantly, in some areas even with 20-30 metres during the observed period. The drop in levels was strongly correlated with changes in land use: the largest drop was observed in urbanized/industrialised areas and is directly caused by overexploitation. On a regional scale, the combination of reduced infiltration (increase in hard surface leads to less recharge, increased run-off, instead of infiltration in mid- and upstream areas) and increased groundwater use overall is the likely cause of this drop.

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THE PRIORITY PROJECTS

Two priority projects were selected in the Welang project for a more detailed analysis. These projects focused on concrete, tangible interventions for flood mitigation in the mid-stream and down-stream sections.

- Mid-stream section: flood prevention in Sidogiri town by water conservation in the Sumber Penang river.
- Down-stream section: additional flood management interventions in the Kraton (Pasuruan) area.

The modelling results for Sidogiro town were inconclusive. The main source of floods in Sidogiri is most likely not the Sumber Penang tributary. Inadequate local drainage is most likely the main reason for incidental floods, perhaps in combination with high flood water levels in the Sumber Penang (preventing adequate local drainage during floods and/or high rainfall events). However, the study lacked sufficient detailed terrain and hydrological information to further analyse this.

The modelling of the Welang river near Kraton provided more useful insights. Various interventions and options were modelled and evaluated on multiple aspects:

- Storing water in the old Welang river arm (Welang Lama), a few kilometres upstream of the Kraton bridge;
- Widening the river, using various shapes;
- Dredging the river, over various lengths;
- Constructing a by-pass river section directly to the coast, downstream of Kraton Bridge, in various shapes and levels.

The retention (long storage) basin in the Welang Lama was quickly discarded as solution as the storage volumes needed to be very large to notice any impact on flood levels (a river storage basin so far downstream must be very large as water volumes are huge). A 10 hectares storage basin of several metres deep, would lead to a maximum of 14 centimetres lower flood levels in the main Welang channel at Kraton.

Modelling of the river widening (namely 20 meters on both sides) showed that this is a highly effective intervention with 30-90 cm flood level lowering near Kraton (depending on the length and depth of widening). However, DPU already constructed several river embankments on the river banks and therefore regarded river widening as no longer an option. This intervention was therefore not further detailed.

Two interventions for further detailing remained: dredging and a by-pass downstream.

Figure 8 Dredged section (A-B), location of the by-pass (C) and the conceptual alignment of the by-pass.

Table 1 Effectiveness and assessed costs of the possible interventions to further mitigate floods in the Welang river.

Intervention	Water level lowering at Kraton Bridge	Effectiveness in cm water level lowering per 1000 m3 soil removal	CAPEX in IDR Annual OPEX in IDR
Retention basin Welang Lama	8-14 cm	0,1 cm/1000 m3	not calculated as option is not effective
River widening	30-90 cm	0,2-0,8 cm/1000 m3	not calculated as option is considered to be not feasible
Dredging: 5,6 kilometres (river mouth to Kraton bridge), 80.000 m^3	40-60 cm	0,5 cm/1000 m3	IDR 60.000.000.000 IDR 6.000.000.000
Shallow bypass (only active during floods) of 1,1 km, next to the gas station, 53.000 m^3	30-35 cm	0,4-0,9 cm/1000 m3	IDR 64.000.000.000 IDR 6.000.000.000

Dredging and creating the by-pass are both more or less equal in both CAPEX and OPEX. Investment costs can be lowered by re-using sediments, for instance to make bricks or for use as construction material. For the by-pass, an annual net revenue from brick making of IDR 5 billion (5.000.000.000) can be expected for a period of 2-3 years. Once the by-pass is finished, no sediment will be available. For the annual maintenance dredging also some revenues can be expected, but revenues will be lower as space is needed for drying of dredged materials (and land is costly). Also, the very fine particles of dredged materials make processing more difficult compared to brick-making from the more silty soils in the bypass. The dredged material, however, can be used to construct embankments using geotubes which are filled with dredged materials. This technology is becoming conventional and is also cost-effective compared to concrete walls or earth-filled dikes.

Nevertheless, it is evident that the investments and operation and maintenance costs of these interventions will be considerable. In view of these costs, and the effectiveness of these measures in the long-term, it is highly recommended to focus on reducing the floodwater and sedimentation volumes through measures in the source areas (namely in the upper and middle-section of the catchment). In the longer term, such measures will be more effective hydrologically and financially.

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THE INTEGRATED RIVER BASIN MANAGEMENT PLAN (IRBMP)

The Welang study also generated a revision of the previous IRBMP (Rencana, 2013) and updated it using the newly collected data and insights. The IRBMP was prepared following the instructions from the Ministerial Decree of Public Works No. 10 /PRT/M/2015 and Ministerial Decree of Public Works No. 4/PRT/M/2015. The regional coordinating water board (TKPSDA) was involved in the preparation of this IRBMP.

The IRBMP acknowledges the many problems in the Welang river basin and calls for action. In line with the responsibilities of the water resources department of the East Java Province, the IRBMP focuses on managing rivers and irrigation channels. While the IRBMP acknowledges the need for a fundamental, more sustainable change in land and water use, most of the concrete actions are sectoral and can be classified as 'building additional hard structures' (dams, reservoirs, check dams and embankments) and dredging. The non-structural actions in the IRBMP are presented in very general terms, as intentions and inspiration.

The IRBMP contains long lists of interventions, all of them being highly relevant. But one may wonder whether the organizational capabilities and capacities of the relevant actors (governmental and non-governmental) are sufficient to implement this long list. A more focused approach with clear goals, tangible results and clear priorities may have provided a more feasible list of interventions.

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CONCLUSIONS

The fluvial floods during the last decade in the downstream (Kraton) area can, to a large extent, be attributed to upstream land conversion and have been exacerbated by downstream sedimentation and encroachment in the urban area itself: the river is constricted. The recent heightening of the concrete embankments in Kraton, will most likely significantly reduce the likelihood of fluvial flooding in Kraton (but could add to pluvial flooding in the vicinity of the river).

The changes in land use and surface water hydrology in the river basin are accompanied by another long-term development: the regional groundwater reserves are recharged less, while groundwater use in urban and industrial areas increases (also due to uncertain availability of good quality surface water). In the longer term, 10-20 years from now, these processes will lead to depletion of vital groundwater reserves and drying up of important springs.

It is expected that land conversion in the upper midstream and upstream areas will continue, considering the current socio-economic developments in the catchment and the various (spatial) development plans of the involved governments and agencies. If not adjusted or combined with the right countermeasures, this will result in a further increase of peak discharges in Welang river. In addition, it will also lead to continuous sedimentation in the downstream reach of the river, which in turn also leads to further heightening of water levels in and around the Kraton area and makes periodical dredging and normalization of the river bed a frequent and costly affair. Without measures in the upper and midstream areas, particularly dealing with land conversion, spatial planning, settlement and infrastructure development, it is expected that the likelihood of fluvial flooding (higher peak discharge, flash floods in tributaries and in the Welang main stream) will increase, with severe impact in the lower midstream and downstream Kraton-Pasuruan areas.

Changes in land use lead to more frequent and larger floods and increased sedimentation in the river bed, especially in the downstream part.

- Over the 2013-2021 period: an increase in height of flood peaks with 10% at Kraton, being 20 cm extra water height.
- At the end of this decade, around 2030, a further increase of flood peak heights at Kraton with 10%, being 25-50 cm extra water height, can be expected.
- Surveys in 2012 and 2017 show that sedimentation of 10 centimeters per year in the downstream section of the Welang river takes place.

The changes in land use also lead to less infiltration and lower groundwater levels overall.

- Model simulations show that a 20-30 meters drop in groundwater levels occurs in the transition area between the upper and middle part of the catchment.

The recent and ongoing rapid urbanisation and economic development has not sufficiently been accompanied by investments in urban drainage systems (Some irrigation channels now double as drainage channels). As a result, the natural and built drainage system has insufficient capacity to deal with larger peak discharge and with high rainfall events. Furthermore, accumulation of uncollected solid waste (plastics) in drains and small streams, leads to suboptimal functioning of the drainage system and pluvial (rainstorm) flooding in the urban centres of Lawang, Purwodadi, Purworedjo and Kraton.

Considering the socio-economic developments, plans and available budgets, it is expected that pluvial flooding may further increase in the near future. Collection of solid waste is expected to improve, and this may result in a reduction of accumulated solid waste in the various waterways throughout the catchment. However, with the continuing urbanisation and prolonged underfunding to upgrade the (urban) drainage systems, it is expected that extent of pluvial flooding will increase.

7

RECOMMENDATIONS FROM THE CONSORTIUM

The consortium views the transition of the land use as the main driver behind the many water related problems in the Welang river basin. This transition should be steered towards a more sustainable direction to avoid serious water problems in the future.

Main threats and challenges:
- More floods, especially in the mid-stream and downstream areas.
- More erosion and sedimentation, loss of valuable agricultural land.
- More landslides in the upstream areas.
- Lower groundwater levels.
- More droughts as groundwater resources are depleted and springs run dry.
- More pollution of water, more waste in the water.

The current strategy to tackle water problems in the IRBMP leans towards solving problems afterwards using conventional civil engineering solutions. Although this might bring the current level of problems under control, over time much bigger and more expensive interventions are required to manage the problems.

More fundamental interventions, namely a coherent soil and water conservation approach for the whole middle and upper catchment are required, addressing the root causes of the problems. Obviously, these interventions must be implemented within the existing legal and governance framework and this makes it difficult for sectoral agencies like PU-SDA to address the complex challenges effectively and consistently.

A truly integrated and interdisciplinary approach, on river basin scale (preferably mostly consisting of non-structural interventions), can complement the current engineering approach of ad-hoc problem solving.

Therefore, it must be considered to involve more strategic and coordinating departments like BAPPEDA (the planning department), sectoral departments (agriculture, forestry, mining and mineral resources, ground-water management), municipalities, communities and NGO's. The PU-SDA department may need to take up a more initiating role, rather than the current role, mostly focusing on partial, sectoral solutions.

The sustainable (soil and water conservation-based) development in the Welang river basin should be done using a common policy framework with jointly defined, concrete goals, strategies and interventions. Important aspects would be:
- Strong water and soil conservation measures in the agriculture, forestry sectors and for the housing/tourism/recreational developments in the upper parts of the river basin; development of multiple, soft and small water retention facilities, measures in the tributaries to stimulate infiltration and reduce run-off and flash floods.
- Mandatory water storage and infiltration of water in urban and industrial areas in the upper and mid-stream part of the river basin.
- Development of waste collection, disposal and recycling systems and reduction of litter.
- Protection of critical vegetation in erosion vulnerable areas; expansion of erosion-reducing vegetation belts.
- Keeping riverbanks clear of constructions (buildings, etc.).

Figure 9 The large scale transition towards commercial agriculture on the steep slopes in the eastern part of the river basin should be given high soil conservation priority.

8

FOLLOW-UP PROJECTS

The results of the Welang study demonstrate in a clear way that the origin of flooding and other water problems in the Welang river basin lies in the rapid transition of the land use from natural/rural to urban and industrial. Also the conversion of originally forested steep slopes into recreational and agricultural areas is an important source of erosion/sedimentation and flash floods. Finally, the internal drainage capacity of fast expanding towns and cities is not keeping up with the pace of the urban development.

It is highly recommended that follow-up projects address these underlying processes, rather than repairing them afterwards with engineering interventions: the many water problems can be controlled to a large degree by a more sustainable development path where soil and water conservation an integrated water resources management (viz. including sustainable groundwater use) are taken into account on all levels: planning, permitting, construction and operation, both on provincial and local level. For this to become feasible, all (governmental and non-governmental) partners in the river basin should agree on the same starting points for more sustainable socio-economic development and operate from this framework.

Part of the assignment was to identify a limited number of important follow-up projects.

Project 1: A joint framework for a sustainable water future in the Welang river basin

The goal of this project could be: creating a joint socio-economic development framework for a sustainable water future in the Welang river basin. All relevant actors (governmental, non-governmental) in the Welang river basin jointly develop a policy framework together with a series of practical soil and water conservation measures for the industrial, residential, agricultural and recreational sectors. Key measures under this framework will aim to: retain water upstream, improve infiltration of water, control erosion, reduce waste and waste water pollution of surface waters. Also: keep river banks free from constructions and buildings.

Project 2: Understanding local floods through monitoring and drainage plans, training of staff

Several flood situations in urban areas are not well understood due to the lack of data. It is likely that several flood situations are a mix of local, pluvial (rainstorm) floods in combination with high flood levels in the rivers, but the current dataset does not allow proper modelling and evaluation. Improving monitoring and data collection is key for a better understanding of local floods. A data collection and monitoring plan would be a good start, but also training of municipal and provincial water management staff on how to obtain and manage more local data is key for better flood management. The development of industrial and urban areas should also go hand-in-hand with expanding and upgrading drainage systems. Major towns at risks are Pasuruan and Sidogiri and urban drainage plans for these towns should be given priority.

Project 3: Consolidating the flood safety at Pasuruan through hydraulic interventions

For now, the area around the Kraton Bridge, Pasuruan may be safe from floods, but it is likely that the future flood water levels will increase as the transition of land use will continue. The current embankments may not suffice in the coming decade. Hydraulic interventions (by-pass, dredging, limited river widening within current boundaries) may provide good complementary safety to the embankments. Further detailing the proposed hydraulic interventions and mixing interventions to 'the best financial and technical feasible mix of interventions', could improve the business case. This technical detailing should be combined with further improving the revenues (brick-making, other re-use options). The deliverable of this project would be a pre-design and business case for the optimal mix of hydraulic and civil interventions, together with an implementation plan.

9

STAKEHOLDER ENGAGEMENT AND TRAINING

Stakeholder engagement

One of the tasks in the Welang assignment was ensure that inclusive stakeholder engagement is properly applied in the river basin study; this was done by actively involving a large number of stakeholders groups and organisations, both intersectoral and from upstream to downstream areas, in an effective manner. A large number of mostly on-line meetings was held to consult, exchange views and discuss. Alltogether, around 80 institutions/organisations/groups from government, academic partners, private sectors, local people, and NGOs were involved for data collection, meetings and workshops, and field visits.

One of the key outcomes of the stakeholder engagement process has been to increase the participation of both governmental and non-government stakeholders for the identification of relevant river basin management issues, gathering of information, and the preparatory discussion of interventions and/or solutions.

Additional results are:

- Capacity built at PU-SDA to design and execute a stakeholder engagement strategy. This includes training of staff, involving PU-SDA staff in practical stakeholder engagement activities and sharing of applicable methodologies and tools;
- Initiated a process of stakeholder engagement for Welang river basin that can be used by PU-SDA for further consultations with stakeholders as new intervention projects are being developed in the coming years;
- Promotion of inclusivity to contribute to the development of a IRBM Plan that is truly supported by communities and other organisations, including those stakeholder groups that are often under-represented, marginalised or vulnerable.

Training and capacity building

The fifth and final component of the Welang study dealt with capacity building and knowledge transfer. For this, a series of training sessions were executed with project consortium experts and the Task Force team of PU-SDA. In addition to the project supported capacity building, a complementary so-called Tailor Made Training (TMT, funded by Nuffic, the Netherlands) is being implemented from March 2021 till April 2022. To guide both tasks an integral training program has been composed called: The Welang River Basin Management Academy. As the name suggests, the focus of the knowledge transfer is on various aspects of integrated river basin management. The program consists of multiple lectures and meetings, a major part has already been conducted (details are presented in the task report).

- Problem-oriented and practical training was conducted with a team of PU-SDA staff.
- In various lectures and meetings, a considerable number of 'external' participants also joined (from regional UPT's (UPT = Unit Pelaksanaan Teknis or Technical Implementation Unit).
- The combination of the training and the active participation of the Task Force team in support of the consultants team in data collection and discussions of plans, designs and modelling proved to be very useful for knowledge transfer to the local team.

In the context of knowledge transfer, training and general awareness another complementary activity should be mentioned, namely the Welang Healthy River Challenge.

The Welang Healthy River Challenge

The Welang Healthy River Challenge engaged young people – university students and young professionals – from across Java and the East Java region to learn about the complex issues facing the Welang River. By working together on the 5-month (part-time) assignment with coaching provided by experienced national and international experts, the students learned about the importance of healthy rivers. They had a learning-by-doing opportunity to develop and present their own ideas contributing to a prosperous and sustainable river basin and communities. The Challenge is a well-appreciated collaboration format to engage the creativity and independent thinking of the next generation to generate ideas and solutions for water related issues. The Welang Challenge was coordinated by The Water Agency and generously supported by a group of Dutch and Indonesian organisations and companies. For more information and frequent updates, see: https://thewateragency.com/service/indonesia-healthy-rivers-challenge-2020-the-final-phase.html

The project consortium

The Welang Flood Management project was executed from December 2020 till early January 2022 by a Netherlands – Indonesian consortium consisting of:

- Lead consultant: Witteveen+Bos Raadgevende ingenieurs B.V. in cooperation with the Indonesian subsidiary PT Witteveen Bos Indonesia;
- Deltares
- The Water Agency
- Wetlands International Indonesia
- HZ University of Applied Sciences
- ITS University, Surabaya
- Rebel Group

The study was executed in close collaboration with the Water Resources Agency – Public Works Department of the Province of East Java (PU-SDA).