Minutes of Meeting – 4th SWG Workshop/ End Presentation dd. 12 December 2025

Project:	Enhance the resilience of Suriname´s Water Supply System by Modelling Drought Risks and Developing a Roadmap of Prioritized Alternatives for Aquifer Recharge
Project Code:	IS-471
Subject:	4th SWG Workshop (Presentation of final results of the project)
Attendance:	See attendance list (Annex 1)
Location:	UNASAT, Hindilaan (Hybrid meeting with Google Meet)
Date:	December 12th, 2025
Time:	09:00 AM – 12:40 PM
Prepared by:	Shaïsta Lachman
Screened by:	Jacobus (Koos) Groen/ Roberto Wong Loi Sing
Minutes of Meeting:	15 December 2025

Subject	Discussion/Comments
Agenda	- Walk-in - Opening and welcome OGM - Presentation 4th SWG meeting - Q&A session - Closure See Annex 2 for the day's agenda.
Opening And introduction	Due to an extended walk-in and some late registrations, the workshop started slightly later than scheduled. Ravindra Patandin (RP) and Jiechel Kasandiredjo (JK) of OGM, welcomed the SWG together with the accompanying Pool of Experts, Resource Persons and relevant stakeholders on national level. The Pool of Experts and Resource Persons introduced themselves. RP also explained the house rules to the participants at the beginning of the session. He outlined the focus of the meeting, a Managed Aquifer Recharge initiative aimed at increasing drought resilience in Suriname (the ARADIS project), implemented by ILACO, Acacia Water and Royal HaskoningDHV with the Ministry of Oil, Gas and Environment as the contracting authority and UNEP as the funding organization. He emphasized that this 4th Stakeholder Working Group session is the last planned session within the project, which started in September 2024. He further noted that the final project results will be delivered this month. The purpose of this session is to inform the stakeholders of the results and outcomes of the project. Eventual relevant comments and suggestions out of today's brainstorming and feedback will be processed in the final report. This closure report will include the results of the social and gender assessment and recommendations, drought study and analysis based on climate change, the MAR technologies evaluated, the field survey and measurements in the selected pilot area at Hanover and Mawakabo together with the design for the well development and conceptual water treatment process and the rough cost estimation and financial benchmarking opportunities.
Announcements	None.

Attendees/ Participating SWG members	**Members of the Stakeholder Working Group, with representatives:**	
	1) Min. Natural Resources (MNR):	Ms. G. Asadang (GA), PS Water; Represented by Mrs. C. Wasmad and others
	2) Surinaamse Waterleiding Mij NV (SWM):	Ms. A. Boedhoe-Hemai (AB);
	3) Stg. Water Forum Suriname (SWFS):	Ms. G. Sno (GS); Not present
	4) Nationale Vrouwen Beweging (NVB):	Ms. E. Graanoogst (EG); Not present
	5) AdeK Universiteit v. Suriname (AdeKUvS):	Mr. M. Huisden (MH); Mrs. K.Gersie (present online)
	6) Entrepreneurs (Ondernemers):	Mr. V. Kisoensingh (VK) (Rudisa Beverages); Not present
	7) Min. Public Works (MPW) (Openb.Werken):	Mr. D. Bhaggoe (DB)
	8) Stg. Water Forum Suriname (SWFS):	Mr. A. Linger (AL); Excused He notified his absence by email
	Pool of Experts	
	9) Ministry of Spatial Planning (Min. OWRO - Dir. RO)	Mrs. T. Warsodikromo & Mr. W. Mahabier
	10) Surinaamse Waterleiding Mij NV (SWM):	Mrs. R. Biswana & Mr. L. Bendt
	11) Min. LVV - Climate Change Unit	Mrs. J. Overman, Mrs P. Sewpersad & Mr. N. Parsadi
	12) Min. Grondbeleid & Bosbeheer (GBB)	Mrs. P. Podrono
	13) Staatsolie N.V.	Mrs. K. Lie A Kwie & Mr. N. Soerdjbali
	Attendees	
	14) Management of Mawakabo Hanover plantation	Chair Person Mrs. M. Inge
	15) Ministry of Oil, Gas & Environment (Min. of OGM)	Mrs. J. Kasandiredjo, Mrs. V. Dipowirono, & Mr. R. Narain

	16) Comm. Wanica Noord-West	Mrs. K. Joeloemsingh & Mr. K. Chotkoe
	17) Comm. Wanica Zuid-Oost	Mrs. L.Tijdmeter & Mr. S. Jhanjan
	18) Comm. Sipaliwini Boven-Coppename	Mrs. N. Vertrouwd
	19) Comm. Wanica Centrum	Mrs. C. Burleson-Wirjotaroeno & Mr. Mr. P. Slamet
	20) Comm. Saramacca	Mrs. H. Seetaram & Mrs. T. Kali
	21) Comm. Boven-Suriname	Mrs. O. Vola, Mr. Eduards & Mrs. L. Haabo
	22) Comm. Sipaliwini – Paramacca	Mr. D. Vasilda
	23) Comm. Para	Mrs. S. Wirip & Mrs. M. Sabajo
	24) Henaturant	Mr. E. Gezius & Mrs. S. Nijman
	25) Stichting Saamaka Lio Development Foundation U.A.	Mr. W. Sanné, Mr. F. Pansa & Mr. K. Soeboe
	26) Nationale Milieu Autoriteit (NMA)	Mrs. G. Becker
	27) Federatie Para Plantages	Mrs. B. Doornkamp

Proceedings of the workshop	

Presentation(s)	The power point presentation (see annex 3) was held by Mr. Jacobus Groen (JG) as Team leader from the consultancy bureau ILACO with the following topics:
	
	A. Objective and recap of the ARADIS project (current status)
	B. Results of phase 2: Analysis
	  1. Explanation of the Drought Analysis and Risks Report
	  2. Explanation of the Aquifers and Water Balances Report
	  3. Explanation of the Managed Aquifer Recharge Report
	  4. Proposal for five pilots.
	  5. Selection of pilot (the Hanover location and the MAR technique using bank infiltration)
	C. Results of phase 3: Design of MAR system Hanover
	  1. Consultation with Hanover stakeholders and site inspection.
	  2. Geophysical Results
	  3. Conceptual Design Well Fields & Proposed Treatment
	D. Conclusion and Final Steps
	
	Ravindra Patandin (RP) also provided an overview of potential funding sources and benchmarking opportunities for supporting a pilot project. This analysis highlighted avenues that could help secure financial backing for the implementation and scaling of similar initiatives.

Explanation of the studies conducted, design of the Pilot MAR at Hanover and last phase of the project	Mr. Groen emphasized the key points. The project began with an inception phase, focusing on data collection as well as stakeholder and gender analysis, given the active role of the Stakeholder Working Group throughout all project phases. The first workshop took place on 5 December last year, during which the inception report was finalized. The key conclusion was to focus on the coastal plain, as this area has the largest water demand, as outlined in the Terms of Reference. The project will primarily address drinking water supply, while also considering agriculture, industry, and bottling companies as potential future users. In Phase 2, the focus was on analyzing drought conditions, climate change impacts, and their implications for water demand. The assessment included aquifers, groundwater resources, and the possible Managed Aquifer Recharge (MAR) techniques suitable for Suriname. Combining these three aspects, five pilot sites with specific techniques were proposed. These were presented to the second Stakeholder Working Group in April this year, resulting in the selection of the Hanover site, where riverbank infiltration will be explored as the chosen MAR technique. Phase 3 is ongoing. Initially, consultations were held with the local community in Hanover, followed by a site inspection. Geophysical surveys were conducted to better understand the subsurface conditions, as limited data was available for the area, with only a few existing boreholes. Based on these investigations, a conceptual design was developed for the well field and the treatment system. This design was presented during the workshop. The next steps include incorporating stakeholder feedback and benchmarking potential funding for the pilot project, with the final reports scheduled to be delivered this month.
Questions	**Questions regarding phase 1 & 2:** **Errol Gezius (EG) - Henaturant:** Just a brief clarification: Such an aquifer; what is it and how does it work? What should I imagine?, is it an open space with a lot of water in it, or does it contain sand, clay, or something like that? **Koos Groen (KG):** Yes, an aquifer such as the one we are currently investigating mainly consists of sand layers. These sand layers can occur at depths ranging from several tens of meters to 300–400 meters in some cases. The water is stored between the sand grains. When you have sand, there are pores between the grains, and these pores are filled with water. This water can flow through the sand, which means the aquifer can be recharged. It is also possible to install a well, allowing the water to be pumped, after which the water flows toward the well. In the case of clay, water is also present, but it cannot flow. This can be observed in practice: when clay is dug up, no water drains out, whereas when wet sand is dug up, water does drain out. Therefore, water within a sand layer is referred to as a permeable sand package, meaning it allows the flow of water. In sand, approximately 30% of the material consists of pores, which is where the water is stored. **Dwane Vasilda (DV) – Commissariaat Sipaliwini Paramacca:** You did speak about fossil water, right? Actually, this relates to what Mr. Gezius mentioned: what should I imagine? Is it a cave filled with water, or is it a sand layer? Is it a layer containing water?

	Koos Groen (KG): It concerns a sand layer at great depth, in which the water is stored within the pores. A long time ago, the landscape in this area was very different, and water flowed through this layer. This water originated from precipitation that infiltrated into the ground and moved through the layer, which caused the layer to become completely filled with fresh water. However, the landscape, climate, and conditions have changed. Sea level has risen, and water no longer flows into this aquifer. The sand layer is now effectively sealed and contains water that has been stored for many years. Although the water can still be pumped out, it is no longer replenished. In this sense, it is comparable to oil: once it is extracted, no new supply is added. **Radjindredath Narain (RN) – Min. OGM:** When looking at pollution, what effect does it have on our aquifers in Suriname? **Koos Groen (KG):** Yes, that is a good question. Pollution is an important issue. In many cases, houses do not have proper sewerage systems or septic tanks, and agricultural chemicals are used. Mercury pollution is also a concern. When considering groundwater, the deep aquifers are generally located beneath thick clay layers, typically at depths of 30–40 meters, 50 meters and sometimes up to 100 meters or more. Multiple clay layers are present in between. As a result, surface contamination may infiltrate the soil, but it would take hundreds to thousands of years for such contamination to reach these deep layers. Therefore, there is no immediate risk to deep groundwater resources. However, when groundwater is extracted from very shallow layers, for example near Zanderij airport, where sand layers are at or close to the surface, or in areas such as Republiek, contamination can reach the wells relatively quickly. In contrast, wells drilled to depths of approximately 150 meters, such as those at the WK Plein, are unlikely to be affected by surface pollution within any foreseeable timeframe. It is highly unlikely that contamination would ever reach such depths. In recharge areas, such as the savanna and regions near Republiek, the risk of contamination is significantly higher. This highlights the critical importance of groundwater protection in Suriname. Proper protection zones must be established, especially when developing shallow groundwater abstractions. If housing with septic tanks is constructed nearby, contamination of the groundwater can occur. Groundwater protection is therefore essential and just as important as groundwater abstraction itself. **Ravindra Patandin (RP):** Have you also taken into account, in the 40% and 20% figures, that a portion of the water entering the aquifer is actually not usable? **Koos Groen (KG):** I assume that with an aquifer, it is never possible to extract 100% of the water. Technically, no more than 40% can be withdrawn. **Ravindra Patandin (RP):** So that is the only level of caution, but not without reason. I know that SWM monitors extensively and probably knows more than they disclose to us. However, I think it is important to emphasize what we are saying: our groundwater resources must be protected. **Walther Sanné (WS) – Stichting Saamaka Lio Development Foundation U.A.:** I am concerned that the discussion about river pollution was not nuanced enough. In the mining area, around Brownsberg, there is significant mercury contamination. It really needs to be clarified that, for example, the Suriname River is not heavily polluted. I am worried that attendees will leave thinking the entire Suriname River is

	contaminated, while in reality, upstream of the sula's it is much less affected by pollutants like mercury. **Koos Groen (KG):** Yes, indeed, that is correct. There is no gold mining in that area, so no contamination is to be expected. **Ravindra Patandin (RP):** Although, our focus was primarily supposed to be on the coastal area, following earlier questions we discussed internally and decided to also give some attention to the inland area. **Walther Sanné (WS) – Stichting Saamaka Lio Development Foundation U.A.:** Upstream in Suriname, most of the vacation resorts are located. The healthcare services are primarily provided by the medical missions. Tourism is also significant. We know that at the end of each school holiday, teachers supposedly travel to the interior and return after several weeks with no access to water for one year or more. Tourism faces similar issues, as transporting drinking water in small containers is not a viable solution. Upstream in Suriname, most tourists visiting the country experience these challenges. These issues need to be addressed in terms of tourism, education, healthcare and for the local population. **Koos Groen (KG):** No, you are absolutely right. In the early 1990s, I already traveled to the interior to set up projects, because at that time nothing had been done yet to drill wells in the hinterland. **Max Huisden (MH) – AdeK:** I would like to emphasize that mercury-related issues are not limited only to areas where large-scale gold mining occurs. Due to the physical properties of mercury, which is volatile at room temperature, mercury vapor is released into the atmosphere. Under certain conditions, when mercury becomes polar or water-soluble, it can return with precipitation. This results in the spread of mercury to locations where gold mining does not necessarily take place, potentially leading to water contamination, especially in areas where water is supplied by surface water. This is a factor that should not be overlooked, as it has implications not only for water quality but also for local biodiversity. **Ravindra Patandin (RP):** Yes, that is correct. The same applies to pesticides. In Nickerie, studies have shown that when planes are used to spray crops, due to wind and other factors, a much larger area can potentially be affected. If surface water from these areas is then used for other purposes, effects can occur. In other words, contamination can spread to areas where no direct application has taken place. **Questions regarding phase 3:** **Errol Gezius (EG) - Henaturant:** Just a technical question: how do they determine, for example in Hanover, that under normal water levels the river remains within its banks? During the rainy season, water levels can rise 2 to 3 meters above normal. How will this affect the installation or its operation? Could it cause overflow or other issues? **Koos Groen (KG):** No, that is a very good point. The measurements initially taken near the village were only about 1 meter above the river level. At that time, it was already noted that the river could rise much higher, so this had to be taken into account. The current location we are considering is approximately 100 meters from

	the river and the ground is slightly higher. There is no indication that the river would reach this location, but it is still a valid point, as water levels do fluctuate. **Ravindra Patandin (RP):** This is also necessary to better define the final location. We have an idea, but it needs to be examined in more detail, including aspects such as property ownership and other considerations. All of this is still required to reach a final decision. **Ravindra Patandin (RP):** I would like to add a note to one of the slides regarding the groundwater agenda. Our project was primarily intended to demonstrate whether it is possible, using infiltration techniques, to secure water even during dry periods. The techniques exist, it has been physically demonstrated and they are applicable in Suriname. This is an important point: while we can imagine solutions that work in other countries, we have shown that these methods can also work here. Choosing the right location is always challenging, as the areas of greatest need are not precisely known, as Koos also mentioned. One of the most important aspects is the protection of water and groundwater resources. If you do not know what you are extracting, it cannot be safely delivered to communities—it may be contaminated initially, or contamination could occur later. Ensuring drinking water quality meets standards such as those required by the WHO is essential for providing safe water for consumption and agricultural irrigation. You cannot use water for irrigation if it is contaminated, as this affects food safety. In the preparatory phase, three main “water” laws were developed. One is the groundwater protection law, another is the groundwater abstraction law and Koos showed a diagram indicating zones that must be protected. This would be formalized in the law, making enforcement easier by clearly defining where activities cannot take place. The third law is the Drinking Water Quality law, regulating oversight of drinking water standards. To my knowledge, these three laws are ready and are expected to be submitted to the Ministry of NH and subsequently to the Council of Ministers for forwarding to the National Assembly early next year. Another important law is the Spatial Planning law. While we aim to implement many initiatives, currently we do not know where activities are permitted. This law will provide clarity on where development is allowed, enabling better planning. The groundwork for this law has already been prepared, although I am unsure of the exact stage. Its purpose is to protect critical water sources and areas highly sensitive to human activities. Land management standards are, once again, a combination of measures. I am not sure who is fully aware of all aspects, but they are particularly important for the districts and the commissioners. Such tools are essential for assessing where activities can take place and where caution is needed. Environmental studies and investigations into contamination are necessary, especially in areas with tourism. For example, it is not sufficient to just set up two cabanas and allow swimming if the water is potentially contaminated. This is exactly why this type of legislation is needed. The Drinking Water Quality law is currently in development, as is a Surface Water Quality law. These regulations are important to prevent swimming or other activities in contaminated areas, which could lead to health risks. I am not implying that this is currently the case, but having these controls in place ensures protection in the future. An important aspect Koos mentioned is funding. **Ravindra Patandin (RP):** Although we did not create a slide on this, we will include a list of potential funding sources in the report.

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The potential funding sources are:

Primary Responsibility of Government:
<ol type="a">
The government is primarily responsible for providing drinking water infrastructure to communities and villages.
Funding comes from the national budget, following the approval process:
<ol type="i">
District-level plans → Ministry of Spatial Planning (adjustments) → Ministry of Finance (budget allocation) → Final approval for expenditure.

Start with small-scale projects to establish discipline and gradually integrate into the budget (e.g., pilot project of $50,000).
Collaboration with agencies like SWM and EBS is essential for implementation and management.

Potential Funding Sources Beyond Government Budget:
<ol start="2">
Green Climate Fund (GCF):
<ol type="a">
Already active in Suriname through various initiatives.
Ministry of OGM is aware.
Large funding opportunities, but projects must meet specific conditions.

Global Environmental Facility (GEF):
<ol type="a">
Suitable for smaller projects ($50,000–$300,000).
Grants (non-repayable), not loans.
Projects must comply with required conditions.

Inter-American Development Bank (IDB): Supports loans and grants.
World Bank – Climate Investment Facility (CIF):
<ol type="a">
Focused on climate-related projects.
Suitable for activities addressing drought or similar challenges.

Caribbean Development Bank (CDB): Active, smaller in scale compared to other financiers.
French Development Agency (AFD): Engaged in drinking water projects in Suriname.
Adaptation Fund: Less known but provides grants for climate adaptation projects.
EU Latin American Climate Fund: Provides grants; Ministries of OGM and Finance are aware.
Invest International (Netherlands): Supports climate change initiatives; partially finances projects depending on eligibility.
Private/Corporate Co-Financing: For example Staatsolie may contribute via community funds or co-financing.

Key Notes:

Projects must meet eligibility criteria and sustainability requirements (construction, maintenance, and management).
Technology integration (e.g., apps for monitoring failures) is recommended.

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	3. Collaboration between government agencies and utilities ensures effective project implementation. 4. Starting small, demonstrating results and gradually scaling is the recommended approach. 5. Once the funding process has been completed and all requirements are met, the project can start; this typically takes a minimum of six to twelve months. However, if government funds are already allocated in the budget, the process can move faster. **Roberto Wong Loi Sing (RWLS):** Two opportunities also deserve attention. One is Carbon Credits income, which are often discussed and which we are constantly on the verge of obtaining and the second is the huge chances that the Oil & Gas boom that is highly expected to surge dollar income for Suriname. This could potentially offer opportunities, but even more importantly, it is essential to plan necessary, relevant and important investments carefully before this money will be spent unwisely. Investment in strategic sectors like water resource protection and utilization especially groundwater is crucial. I think it is important to propose a well-considered and useful allocation in advance, to ensure that any funds are not wasted, but instead invested in meaningful and important initiatives. That is the main point I wanted to highlight. **Ravindra Patandin (RP):** Yes, that's correct. I am not entirely sure whether carbon credits can be used for everything; I believe they are primarily linked to deforestation and related activities. Nevertheless, you are right—this is just one option among several. Ultimately, we advocate for an integrated approach, not only technically but also financially, while considering the organizational framework. The key stakeholders are already present: the Ministry of OGM, SWM, the Ministry of NH and Ministry of GBB, which I had almost forgotten to mention, but is important when discussing land and forests in the interior. In short, the idea is for the parties to coordinate, as it were and develop an integrated plan to fully explore the potential of groundwater for both drinking water and irrigation purposes. **Errol Gezius (EG) - Henaturant:** Regarding the exercise with the infiltration method: on one hand, it is considered safe because the water passes through a sand layer which naturally filters it. Yet, you also talk about protecting the riverbanks and preventing contamination. Does this mean that certain substances can still pass through, or am I misunderstanding the extent to which the method filters different types of substances? **Koos Groen (KG):** Well, the water is in transit, moving from the river to the wells. However, activities could suddenly occur along the way for example, someone could build a septic tank nearby, but ideally that would not happen. It is mainly activities around the wells that could cause contamination. If such activities occur very close to the wells, the water has a very short residence time, and the contamination will not be naturally removed. The design must ensure that the water from the river has sufficient travel time before reaching the wells. At the same time, it is essential to prevent any contaminating activities in the surrounding area in the future. We can design the system as we like, but if people suddenly build roads or houses nearby, the design alone will no longer provide adequate protection. **Ravindra Patandin (RP):** Referring to slide 36 of the presentation, which essentially represents a circle around a source where activities are taken place, RP

	emphasizes the importance of protection zones. If any activity takes place within that circle, the likelihood of contamination reaching the source is much higher. Conversely, as explained, if activities occur outside the circle, by the time any potential contamination reaches the source, it is very likely to have dissipated or been neutralized. This process can take a long time. **Ashwinie Hemai (AH) – SWM:** A comment from my side: I noticed that this was a very technical presentation, which may not be entirely clear to everyone how the drinking water supply actually works. In particular, I see many people from the district commissioners' offices here. I therefore invite you to visit SWM stations in the various districts. Visiting SWM stations is important for you to understand the significance of protecting groundwater, how the process works and the role of protection zones where permits are required for economic activities. This helps you understand your influence on whether a permit should or should not be granted. We are currently facing a case where, immediately downstream of one of our sources, the Helena Christina pump station, a fuel station is being built. There are risks involved, which have been noted. Work has been requested to stop, but permits may still be granted, raising the question of how to proceed and where to go to address the issue. This concerns an existing drinking water source, which predated the construction of the pump station. These are issues that district commissioners and government officials should be aware of, as they are approached for advice regarding permits. I therefore invite you to arrange a visit through the PR department of SWM to see how the drinking water supply and treatment process is safeguarded. Protecting drinking water for the people of Suriname is extremely important; otherwise, we risk not having safe drinking water in the future. **Koos Groen (KG):** If the legislation had already been implemented and the protection zones had been defined and included as an annex to the law, this situation would never have occurred. The law clearly states that a fuel station cannot be established within these protected areas. **Ravindra Patandin (RP):** It's not only fuel stations; there are also many small businesses, such as eateries. They often build a toilet with a septic tank nearby. What do you think will happen if this occurs within 10 meters of a water source? We have witnessed this happening. **Sandra Nijman (SN) – Henaturant:** The area in question in this pilot study is Hanover. However, I wonder when activities will actually begin. The local community is small, but many people frequently return to Hanover. If the community is not informed about such activities, there is a risk that they might undertake their own activities within the area. **Koos Groen (KG):** Yes, I understand, but this is a pilot project. The entire project is intended to demonstrate how water can be extracted using this method. Hanover was chosen as the site, but I must emphasize that there are currently no follow-up plans. It is purely a pilot to show that it is feasible. As for future developments, I am not sure. I don't know whether Hanover will need 300 m^3 per day, but it is likely not. Any further implementation would have to be integrated into a larger plan. **Ravindra Patandin (RP):** Developing groundwater production in this area must be based on a need. I understand that development plans are either underway or being

	prepared. If actions are planned for two years from now and there is already a possibility, it makes sense to consider protecting the area in advance. This plan lies with the ministry, together with NH and SWM. An integrated approach is necessary to determine the next steps, which should be further developed by one of the ministries. There is a need, there is a possibility and the next step is for the ministry to forward it to NH or SWM to handle if it concerns drinking water. It is not only about drinking water, electricity and other utilities are closely linked, so both need to be considered if development proceeds. The same principle applies to the entire Upper Suriname region. It is difficult to implement initiatives without an integrated approach. Incidentally, we are involved with several villages to explore how to provide electricity, water, and telecommunications simultaneously. This integrated approach allows for better village development, as opposed to ad hoc solutions. **Koos Groen (KG):** Regarding Hanover, I have heard that there will be a future water demand at the airport. This could potentially be combined with the Hanover pilot, as the airport would require more water, and Hanover could 'piggyback' on that supply, since its demand is still relatively low. **Ravindra Patandin (RP):** As I mentioned before, there might be an opportunity to sell water with the help of SWM. Of course, the exact pricing and arrangements would need to be determined, but it could also support local development. For Hanover, this could be a potential option. I recall that about 15 years ago, we considered a similar approach for the interior. The idea was to set up several stations and, instead of transporting bottled water all the way from Paramaribo, produce and bottle it locally in larger containers. These could then be distributed to villages in need, particularly where no station exists. Such options are feasible and could be explored. **Wirish Mahabier (WM) – Min. OWRO:** Concerns were raised regarding life-threatening situations, such as potential contamination of groundwater by a pump station or fuel. The question is, however, that before the water reaches the community, it undergoes a thorough purification process. Would the water still be considered hazardous after passing through such a treatment process? If a proper purification process is in place, would it really matter if, for example, a toilet is located 2–10 meters away or if a fuel station is nearby? **Koos Groen (KG):** If you apply a very advanced purification process, such as reverse osmosis, you can remove all contaminants. However, this is expensive. A simple sand filter works quickly, but it is insufficient to eliminate pathogenic bacteria, as they require more time to die off. So while a sand filter alone cannot remove all pathogens, reverse osmosis could, but at a significantly higher cost. **Ravindra Patandin (RP):** When designing a water treatment plant, the first step is to assess the quality of the raw water and each treatment process is tailored accordingly. For example, some areas have very high iron content, which requires additional aeration and extra treatment steps to reduce the iron levels. Other areas have little or no iron, so the process is adjusted accordingly. The design always starts with the known water quality. If there are contaminants such as oil in the groundwater, a simple sand filter will not suffice. In such cases, additional treatment methods are required, which may increase costs and require adjustments to the system.

	Once a treatment plant is operational, any new contamination requires modifications. For instance, if deep groundwater is initially free of bacteria but septic tanks are present nearby, adding contaminants like BOD could occur. The treatment may then require additional disinfection, such as chlorination, before the water is supplied to consumers. In summary, water treatment is always adapted to the existing quality and potential risks. Based on our experience with SWM, which sources and facilities need to protected, we advocate for maximum protection of water sources to minimize variables and reduce the need for adjustments over time. **Ashwinie Hemai (AH) – SWM:** The point is, as you indicated, that a treatment plant is designed based on a certain raw water quality. If new economic activities occur in the area and affect the raw water, the existing treatment process may no longer be adequate. This means that the cost calculations for producing and supplying water to the population must be reconsidered, as additional treatment steps may be required. Implementing these extra steps can significantly increase the cost—potentially making the treatment three times more expensive than the current water supply. Therefore, the issue is not just about technology, but also about what constitutes affordable and acceptable water for the Surinamese population. This is why SWM continues to use conventional treatment techniques, which keep drinking water affordable. Advanced treatment technologies could be applied, but then water would no longer be affordable for a large part of the population. **Ravindra Patandin (RP):** For reference, in the past, water cost about 1 US dollar per m^3. Over time, treatment has become more advanced, which could reduce costs slightly, but we are not reaching that previous amount. Regarding SWM, the refinery of Staatsolie cannot process all types of oil; certain types cannot be mixed because it would cause operational issues. Therefore, exact specifications must be followed. **Chequita Wasmad (CW) – Min. Of NH:** Installations in the interior that use reverse osmosis are provided free of charge. The communities do not pay before receiving water. This applies, for example, in areas Boven Suriname. **Pamela Podrono (PP) – Min. Of GBB:** The directorate I work with focuses mainly on protected areas, not the whole of Suriname. However, it is a concern to monitor activities such as weg naar Mata where deforestation and sand excavations takes place. These can have a significant long-term impact on our groundwater supply. These factors must also be taken into account. **Ravindra Patandin (RP):** Exactly. It is not only gold mining but also sand extraction sites. You just mentioned Billiton or Suralco, where sand is extracted from 30–40 meters deep. Now, if sand is being extracted near a drinking water source, perhaps for commercial purposes, this could compromise the water source. Even if it is economically more profitable than placing two new drinkwater wells, the existing source would no longer function properly, which poses a significant problem. **Dewdath Bhaggoe (DB) – Min. OW:** I would like to add something. My colleague mentioned septic tanks. Looking at the district authorities and commissioners, they have an important role to play in monitoring these situations. They must ensure that contamination is minimized or, ideally, completely prevented.

	Ravindra Patandin (RP): Exactly. We continue to emphasize that monitoring is important, but what is even more crucial is preventing contamination from occurring in the first place through proper protection measures. **Roberto Wong Loi Sing (RWLS):** The Chairperson of the Federation of Para Plantations Mrs. B. Doornkamp (BD), mentioned during the break that the situation of Para river is quite concerning. According to the information they have, the perceived good quality of water on the plantations is actually deteriorating. Unfortunately, she had to leave before I could discuss this with her personally, but it may be relevant to include this in future considerations. I also spoke with Mr. Sanné, who indicated that in the interior, communities are beginning to drill their own groundwater wells. My question is whether, in the future, the government or related programs could provide guidance or support for these initiatives. Proper preliminary research and mapping of multiple areas could help reduce the high costs and uncertainties involved, as drilling in rocky areas may not yield water and loss of scarce financial resources. Some support could enable communities to be more self-reliant and successful in their water initiatives. **Walther Sanné (WS) – Stichting Saamaka Lio Development Foundation U.A.:** There are many entrepreneurs in Suriname with great ideas, but the problem lies in the lack of financial resources. While funding institutions exist, it is never easy to access these funds. Two main issues prevent this: lack of familiarity with the process and difficulty in writing project proposals. In Suriname, there are very few people who know how to write projects, yet the demand is enormous. There is a need for project bureaus or centers where individuals can get guidance on developing proposals. Even after a project is written, the challenge continues. Once submitted to the government, projects are often mishandled or influenced by political interests, resulting in poor implementation. There is a real risk that government officers may appropriate projects and execute them poorly, causing the funding to be wasted. This discourages entrepreneurs and limits citizen participation. Therefore, it is crucial to establish a dedicated bureau or system to support project writing and implementation, ensuring that ideas from Surinamese citizens can be properly realized and benefit the country. **Ravindra Patandin (RP):** It is indeed frustrating when good ideas are either not implemented or taken over. In the past, there were initiatives such as the Community Development Fund Suriname (CDFS) and other development funds for the interior, which had good intentions but, over time, may have been discontinued due to various reasons. So, while it is not impossible, your point is valid. Years ago, at the Ministry of Planning and Development, I advocated for the establishment of a so-called project bureau, where a dedicated team could prepare and manage such initiatives. This would ensure that both external funds and government budgets are better utilized. For example, if 1 billion SRD is allocated for the interior over the next three years, it should be spent effectively to support development. Your point is valid and will certainly be reflected in the report. **Radjindredath Narain (RN) – Min. OGM:** I have a question regarding the construction of landfills, whether legal or illegal. What impact do they have on flooding on the aquifers? **Koos Groen (KG):** It is certainly not good that during floods, waste can be washed everywhere. Regarding landfills in the city, as I mentioned earlier, waste will not

	reach the deep aquifers, so that is unlikely to happen. However, during flooding, waste can be carried along, which is obviously undesirable. The deep groundwater may not be immediately threatened, but it is still a negative situation. The impact can be different in the interior, such as in the savanna, where if waste spreads to areas with wells, contamination could reach those wells. Therefore, the consequences depend on the location of the waste, whether it is on the surface or deeper underground. In the coastal plain, with clay layers above, it is unlikely to reach the deep aquifers. **Ramona Biswana (RB) – SWM:** There is an error in one of the slides (slide 38 of the presentation). SWM does not have a station at Afobakaweg. Please remove it. The wells are shown as locations, but they were never commissioned or put into operation. Only the locations exist; the wells were never drilled. Those wells belong to Suralco; not SWM's. **Koos Groen (KG):** There are drill logs of these wells. The wells were not developed into stations.
Closure workshop	Wrap-up and closing remarks were delivered by RP, following KG's explanation that the final step involves benchmarking potential funding sources and delivering the final reports. The next step is to finalize all reports, including the report on benchmarking potential funding sources. Final reports, including annexes and progress reports (AFCIA Results Tracker, TA ME Plan Impact Statement Form and Closure Report), are now on the agenda. The final reports will be officially submitted on 19 December 2025.
Closing	The closure statement of this successful stakeholder's workshop was done by Samantha Kromoredjo (SK) of OGM. Thanks were given for the fruitful collaboration during the discussions and brainstorming sessions. SWG Workshop #04 closed at 12:40 PM with a lunch.

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Photo report

Project: Enhance the resilience of Suriname´s Water Supply System by Modelling Drought Risks and Developing a Roadmap of Prioritized Alternatives for Aquifer Recharge (ARADIS)
Project Code: IS-471
Subject: Photo report of 4th SWG workshop 12th of December 2025

Photo 1 Welcoming speech of the ARADIS Project 4th SWG Workshop by the Min. OGM Acting Deputy Director for Environment & Ecosystems Mrs. J. Kasandiredjo

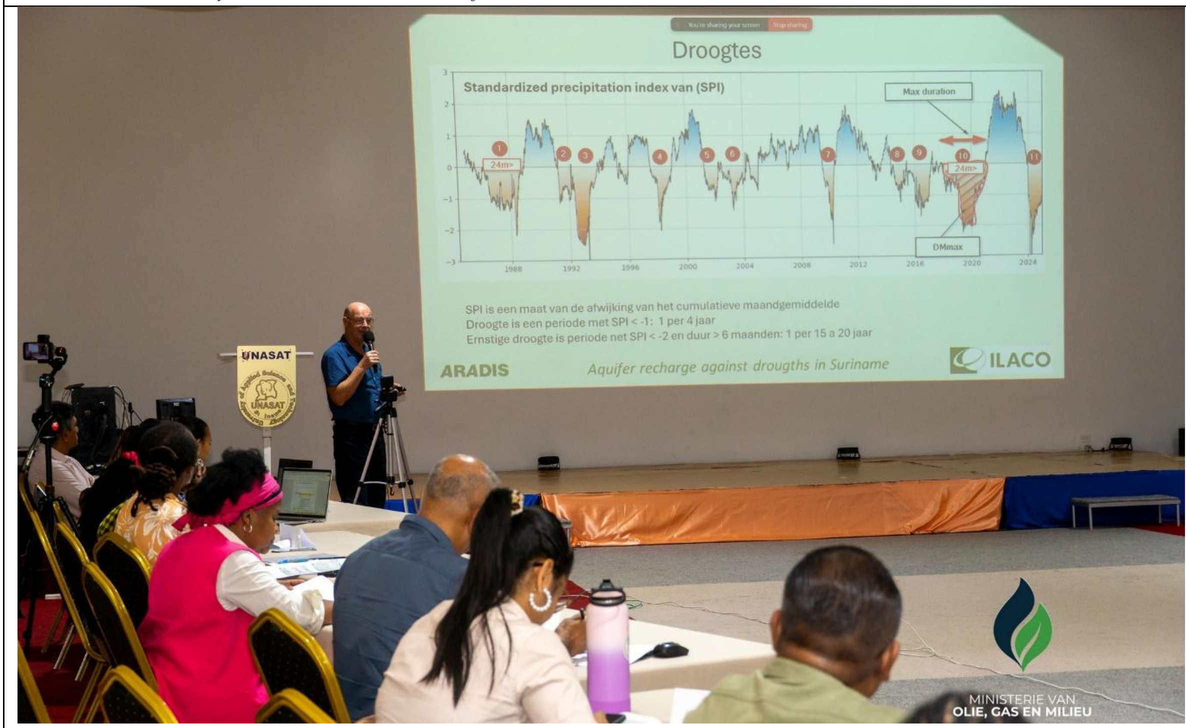

Photo 2 Presentation by Mr. Jacobus (Koos) Groen regarding the results of phase 2

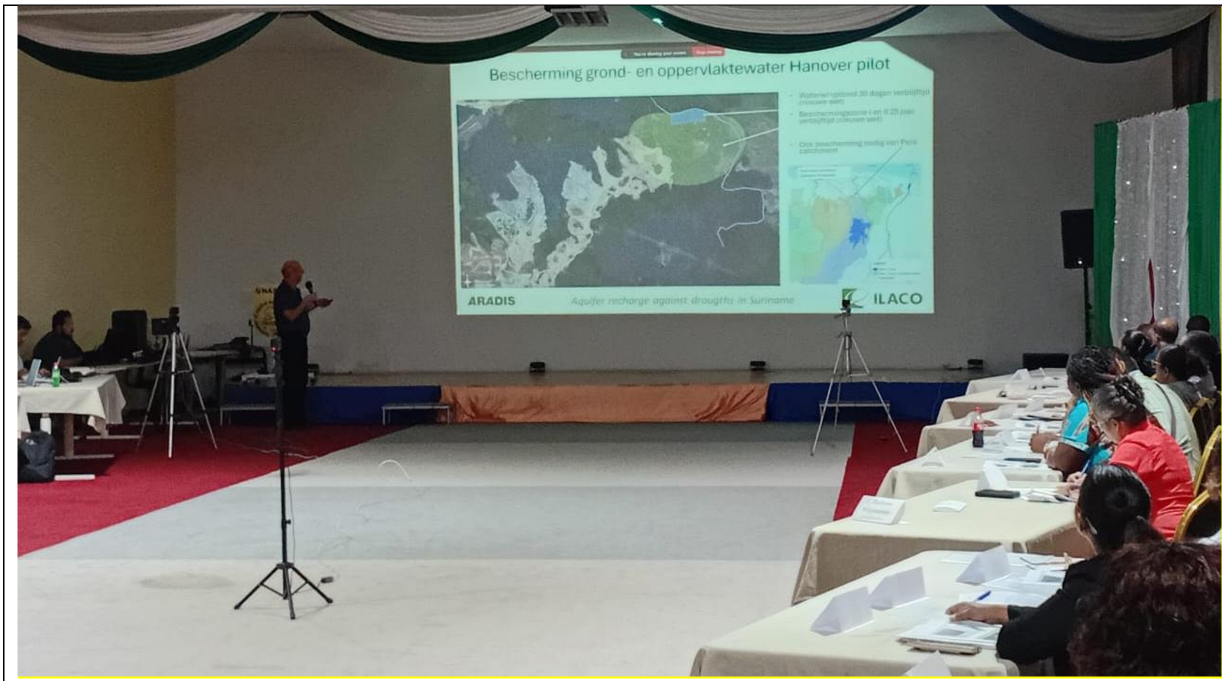

Photo 3 Presentation by Mr. Jacobus (Koos) Groen regarding the results of phase 3

Photo 4 Overview of stakeholders who participated in the meeting #1

Photo 5 Overview of stakeholders who participated in the meeting #2

Photo 6 Overview of stakeholders who participated in the meeting #3

Photo 7 Stakeholders fully participating during Question and Answers (Q&A) session #1

Photo 8 Stakeholders fully participating during Question and Answers (Q&A) session #2

Annexes:

1) **Annex 1 Attendees List (Presentielijst) 4th workshop_12 December 2025**

2) **Annex 2 Agenda (Dagprogramma) 4th workshop_12 December 2025**

3) **Annex 3 Presentation ARADIS Proj 4th SWG Workshop 12 December 2025**

MINISTERIE VAN OLIE, GAS EN MILIEU

CTCN UN Climate Technology Centre & Network UNFCCC Technology Mechanism

ILACO

Project: Enhance the resilience of Suriname´s water supply system by modelling drought risks and developing a roadmap of prioritized alternatives for aquifer recharge

Locatie: UNASAT, Hindilaan **Datum: Vrijdag 12 December 2025** **Tijd: 09:00u – 13.00u**

Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
M	Jacobus (Koos) Groen	ILACO N.V.	ARADIS Teamleader	groen.watersolutions@gmail.com		
F	Jacintha Groen					
M	Ravindra Patandin	ILACO N.V.	Directeur	r.patandin@ilaconv.com	8852023	
M	Roberto Wong Loi Sing	ILACO N.V.	ARADIS Dep. Teamleader	r.wongloising@ilaconv.com	8579192	
M	Radjen Ramkisoen	ILACO N.V.		r.ramkisoen@ilaconv.com	8991221	
F	Shaista Lachman	ILACO N.V.	Project Ingenieur	s.lachman@ilaconv.com	8655610	
M	Glenn Blokland	ILACO N.V.	Consultant	bloklandglenn6@gmail.com	8515223	
F	Josta Nieuwendam	ILACO N.V.	Gender Consultant	joseefie@gmail.com	8892782	
F	Samantha Kromoredjo	Min. OGM	Beleidsmedewerker	samantha.kromoredjo@outlook.com	8599665	
F	Jiechel Kasandiredjo	Min. OGM	Wnd OD Leefomgeving en Ecosystemen	Jiechel.kasandiredjo@ogm.gov.sr		

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Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
M	Radjindredath Narain	Min. OGM		r.narain27@hotmail.com	89952-14	
F	Vijona Dipowirono	Min. OGM	Environmental Policy Officer	vijona.dipowirono@gov.sr	8261495	
F	Ramona Biswana	SWM; afd. Planning en Onderzoek	Sr. Beleidsmedewerker	r.biswana@swm.sr	8656028	
F	Ashwinie Hemai	SWM	OD Strategie en Beleid	a.hemai@swm.sr	8512001	
M	Lionel Bendt	SWM		l.bendt@swm.sr		
M	Marcel van Huisduinen	SWM	Medewerker Planning en Onderzoek	M.Huisduinenvan@swm.sr	8641030	not present
M	Dewdath Bhaggoe	Min. OW	OD Onderzoek en Innovatie	dew_bhaggoe@yahoo.com	8535887	
F	Janice Overman	Ministerie van LVV		ccu.lvv.2023@gmail.com		
M	Niraj Parsadi	Min. LVV	Policy officer	"	8889237	N.P.
F	Petra van Dams	Min. LVV				not present
F	K. Joeloemsingh	Commissariaat Wanica Noord-West	Vertegenwoordiger	secretwanicanoordwest@gmail.com	8539735	

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Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
M	K. Chotkoe	Commissariaat Wanica Noord-West	Vertegenwoordiger	ictdependancewanica@gmail.com	8525575	
F	Pamela Podrono	Ministerie Grondbeleid en Bosbeheer (GBB)	Vertegenwoordiger	podronopam@gmail.com	8726536	
M	Roy Ho Tsoi	Ministerie Grondbeleid en Bosbeheer (GBB)	Vertegenwoordiger			present
M	Naresh Soerdjbali	Staatsolie N.V.	HSE Superintendent		8784684	
F	Karin Lie A Kwie	Staatsolie N.V.	Sr. HSE Coordinator	KLieaKwiE@Staatsolie.com	8914354	
F	L. Tlijdmeter	Commissariaat Wanica Zuid-Oost	Hoofd Buitendienst	tijdmeterlucretia@gmail.com	8686690	
M	R. Amatoeloes	Commissariaat Wanica Zuid-Oost	Hoofd CTD			not present
M	S. Jhanjan	Commissariaat Wanica Zuid-Oost	Ressort Leider	[illegible]@hotmail.com	8106722	
M	Errol Gezius	Henaturant	Vertegenwoordiger	errolgezius@gmail.com	8544147	
F	Sandra Nijman	Henaturant	Vertegenwoordiger	snijmang@gmail.com	8625163	
F	Truus Warsodikromo	Min. OWRO		Wtruus98@gmail.com		present

Project: Enhance the resilience of Suriname´s water supply system by modelling drought risks and developing a roadmap of prioritized alternatives for aquifer recharge

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Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
F	Marjolein Cadogan	Henaturant	Vertegenwoordiger			not present
M	E. Gezius	Plantage Hanover				present
F	Kathleen Gersie	AdeK				Online
	J. Sandiman	Commisariaat Wanica Centrum	ABO			not present
F	Patricia Sewpersad	Min LVV – Dir Landbouw		patriciasewpersad@gmail.com		not present
	Vertrouwd N	Commissariaat Sipaliwini – Boven Coppename	Secretaresse	Struiken Naomi 3 gmai	8790187	
	Renfurm L	Comm. Sipaliwini – Boven Coppename				not present
	Alihoesein S	Comm. Sipaliwini – Boven Coppename				not present
F	Morishi Selindia	Comm. Sipaliwini - Coeroeni	DC	selindia05morishi99@hotmail.com		not present
M	Saridjoe	Comm. Sipaliwini - Coeroeni	DS			not present
F	Melissa Inge	Bestuur Plantage Hanover		hamaplantage@gmail.com	8598305	

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Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
F	May Ornis	Comm. Sipaliwini - Coeroeni	BO			not present
F	Chermine Burleson - Wirjotaroeno	Comm. Wanica Centrum		wrjtme gmail. com	8748401	
	P. Slamet	Comm. Wanica Centrum	B. O.	firizah pat@G mail	8812594	
F	Heimwatie Seetaram	Comm. Saramacca	OBog	Lovelynicelovelysweet@gmail.com		
F	Trishala Kali	Comm. Saramacca	BF2-medew.	trishala1998@hotmail.com	8617613.	T.Kali
M	Walther Sanné	Stichting Saamaka Lio Development Foundation U.A.		depthhinterland@protonmail.com	8935383/ 8186481	
M	Francis Pansa	Stichting Saamaka Lio Development Foundation U.A.	Directeur			
M	Klarens Soeboe	Stichting Saamaka Lio Development Foundation U.A.				
F	Geneva Becker	NMA				
M	Amar Durga	Future Beverages N.V. (Basic One)	Operations Manager	amar.durga@fbsur.com	8521110	not present

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Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
F	Femia Wesenhagen	Min. OWRO		Femia2002@yahoo.com		not present
M	Earl Djojokasiran	Min. OWRO	OD Databeheer			not present
F	Truus Warsodikromo	Min. OWRO	Adviseur (Weather /water)	Wtruus98@gmail.com	8155397	[signature]
F	Augusta Zeeuw	Min. NH – afd. IWB		zeeuwaugustanh03@gmail.com		not present
F	Chequita Wasmad	Min. NH – afd. DWV	Hoofd Beleidsmedewerker	charmeher@yahoo.com	7251410	[signature]
F	Tamara van Ommeren	AdeK		Byrty41@yahoo.com		not present
F	Oclaya Verwey	Bestuur Plantage Hanover	Adviseur	osverwey@gmail.com	8668226	not present
M	F. Krak	Bestuur Plantage Hanover				not present
M	R. Panka	Bestuur Plantage Hanover				not present

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Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
F	Eline Graanoogst	de Nationale Vrouwenbeweging		nationalevrouwenbeweging@gmail.com		not present
M	Max Huisden	AdeK	RC Milieuwetenschappen	huisden@ufl.edu	8821421	
M	Swami Girdhari	VEAPS	Secretary	veaps.suriname@gmail.com	8844008	not present
F	Tania Lieuw-A-Soe	Federatie Surinaamse Agrariers		fsa.suriname@gmail.com	8844008	not present
M	Mario Jacky		Waterboring initiatiefnemer Binnenland		5946940 92927	not present
M	Patrick Kensenhuis		DC Para		8725253	not present
M	Sherwin Pique	Federatie van Para Plantages	Secretaris		7220640	not present
F	Siemla Kuldipsingh	MIN. v. NH	Beleidsmedewerker	kuldipsingh.siemla@gmail.com	8724328 8221247	SK.

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Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
	Vila Olivia	Comm. Boven-Sur	ADS	oliviavila0@gmail.com	7152132	[illegible]
	Haabo Hyzia	Comm Boven-Sur	ABO	utiel 1988	7149539	[illegible]
	HOBOI.R	GBD CBB-NB	CB	joensang@yahoo.com	8895106	[illegible]
	Nasio D.	Ministerie Olie, Gas en Milieu	Hoofd Voorlichting	donovan.nasio@gov.sr	8444722	[illegible]
	Edwards	Bov.-Sur	A.O.S.		7640789	Edwards
	Varilda	Commissariaat Paramaribo	DS	dwanevarilda@gmail.com	8922886	[illegible]
	Sewpersad	ministerie LVV	Beleidsmedewerker	PatriciaSewpersad@gmail.com	8523904	Sewpersad
	Wirip Stephany	Comm Para	ABO	wiripstephany0@gmail.com	8949221	SWirip

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Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
V	Pet Pardith	NH	Beleid med.	Darlingforever26@gm	8243498	P.P
M	Bhaggoe	OWRO	OD	dew_bhaggoe@yahoo.com	8535887	B
m	Mahabier W	OWEO	MPU	wiwinmahabier owe gmail.co		8564318
	Doorham	fpp	lid	nagibaber@gmail		854932

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Gender	Naam	Organisatie	Functie	Email	Mobiel	Paraaf
F.	Sabajo Monalisa	Commissariaat Para	B.O.	Monalisa.sabajo@gmail.com	8917422	

Programma

08:30 – Inloop
09:00 – Welkom en Opening
09:10 – Toelichting dagprogramma en huishoudelijke mededelingen
09:15 – (Korte) Kennismakingsronde

09:30 – Inleiding en Achtergrond Project

09:45 – Overzicht, Doelstellingen en Verloop van het Project

10:20 – Break

10:40 – Toelichting 3 fasen en behaalde resultaten

12:00 – Wrap up en Vragenronde

12:50 – Afsluiting en Dankwoord

13:00 – Einde Workshop

- Lunch

Enhance the resilience of Suriname´s Water Supply System by Modelling Drought Risks and Developing a Roadmap of Prioritized Alternatives for Aquifer Recharge.

Acronym: **ARADIS** (Aquifer Recharge Against Drought In Suriname)
MAR = Managed Aquifer Recharge = Ondergrondse opslag van opp. water

Consortium en team:

- ILACO Suriname: Robert Wong Loi Sing, Koos Groen, Ravi Patandin, Radjen Ramkisoen
- RHDHV Nederland: Harmen van de Berg
- Acacia Water Nederland: Jaap Paape

Client: Ministry of Oil, Gas & Environment

Donor: UNEP/CTCN

Time period: 15 months

Dagprogramma

08:30 – Inloop

09:00 – Welkom en Opening

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- Lunch

Objectives

- Exploring feasibility of MAR to mitigate effects on groundwater related to:
  - droughts,
  - climate change,
  - Salinization,
  - Overexploitation.

- Target areas are:
  - the coastal aquifers
  - high demand areas

90 % population in coastal districts
44 % in Paramaribo

Project outline

Phase 1: Inception

- analysis of stakeholders,
- analysis of gender roles,
- inventory of data,
- draft inception report
- establishment and consultation SWG
- preparation of inception report

Phase 2: Analysis

- Droughts, climate, water demand
- Aquifers, water balances
- MAR technology
- Preselection of 5 potential MAR pilot sites
- Consultation of SWG and selection of pilot site

Phase 3: Conceptual design

- Consultation of local stakeholders
- 3D aquifer mapping (geophysics)
- Wells and well field
- Water quality and water treatment study
- Draft design of MAR system
- Consultation and design approval of SWG
- Benchmarking financial sources for follow up
- Final workshop on broad perspective on groundwater and MAR with SWG and other stakeholders

Fase 1: Inceptie

Fase 1: Stakeholder Mapping & SWG

Phase 1: Inception

- analysis of stakeholders,
- analysis of gender roles,
- inventory of data,
- draft inception report
- establishment and consultation SWG
- preparation of inception report

Fase 1: Stakeholder Mapping & SWG

Table 2: Stakeholder Mapping7

Stakeholder			
A. Stakeholders affecting the Lack of Water Supply	**Influence**	**Interest**	**Impact**
1. Water Supply Companies	High	High	High
2. Industrial Sectors	High	Low	High
3. Government Agencies	High	Medium	High
4. Urban Developers	High	Low	High
5. Agricultural Practices	High	Low	High
B. Stakeholders impacted by the Lack of Water Supply:			
1. Water Supply Companies	High	High	High
2. Local Communities	Low	Medium	High
3. Agricultural Producers	Medium	High	High
4. Health Institutions	Medium	High	High
5. Businesses/Organizations	Medium	High	High
C. Policymakers, Data-collection/Research, Knowledge Institutes			
1. Government Officials	High	Medium	High
2. Environmental NGOs	High	High	High
3. International Organizations	High	High	High

	Stakeholder Working Group		
Gender	**Name**	**Institute**	**Role**
F	Gonda Asadang	Min. NH	Dir. Water
M	Alwin Linger	Water Forum	
M	Dewdath Bhaggoe	Min. OWRO	Dep. Dir. Research and Innovation
F	Gladys Sno	Water Forum	
F	Ashwinie Hemai	SWM	Dep. Dir. Strategy and Policy
F	Eline Graanoogst	NVB	
M	Max Huisden	AdeK	AdeK - RC Environmental Sciences
M	Vinood Kisoensingh	RUBECOM N.V. (RUDISA)	Plant Manager / Mechanical Engineer

Fase 2: analyse

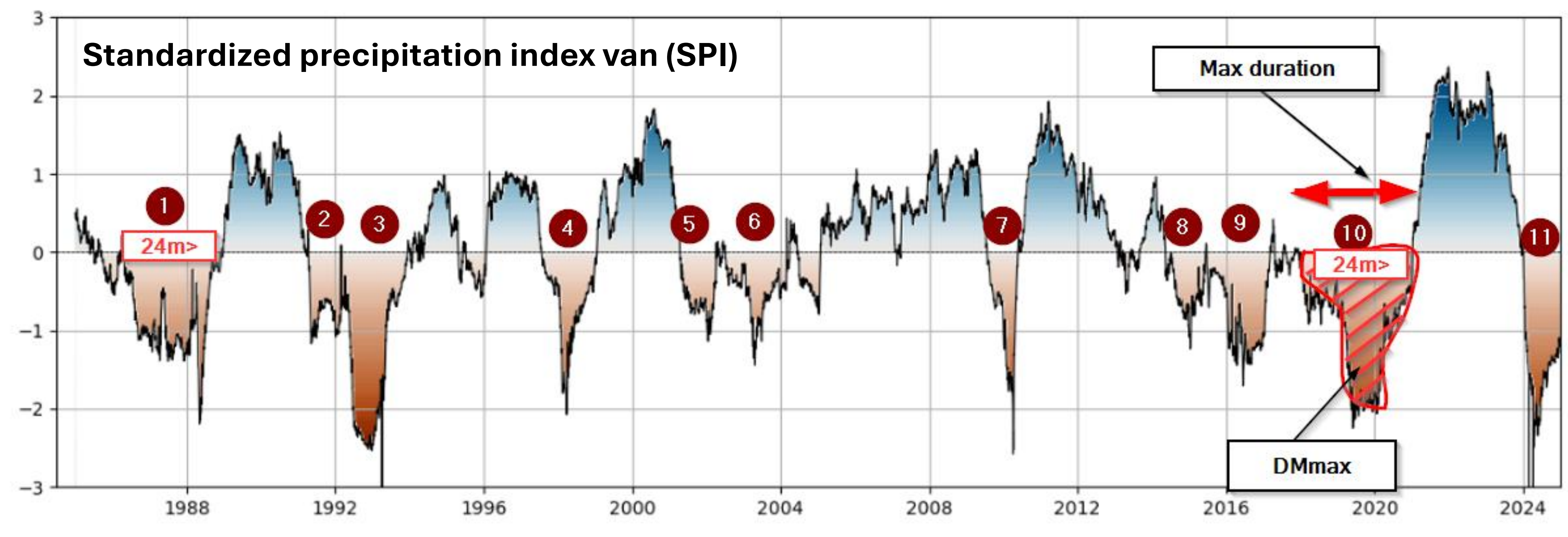
Droogtes

DBS, april , 2024

Wijdverbreide afname landbouwproducten door droogte, De West, april 2024

De West, Bigi Pan, feb 2024

Droogtes

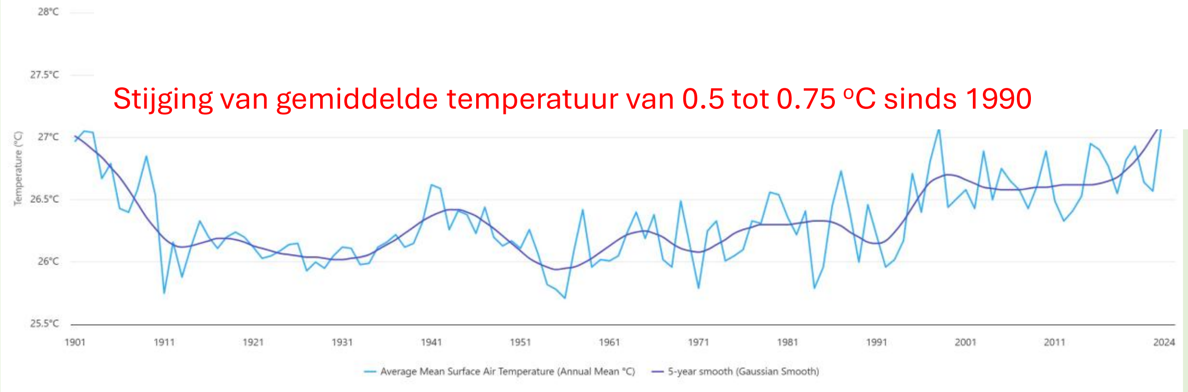


SPI is een maat van de afwijking van het cumulatieve maandgemiddelde
Droogte is een periode met SPI < -1: 1 per 4 jaar
Ernstige droogte is periode net SPI < -2 en duur > 6 maanden: 1 per 15 a 20 jaar

Climate change

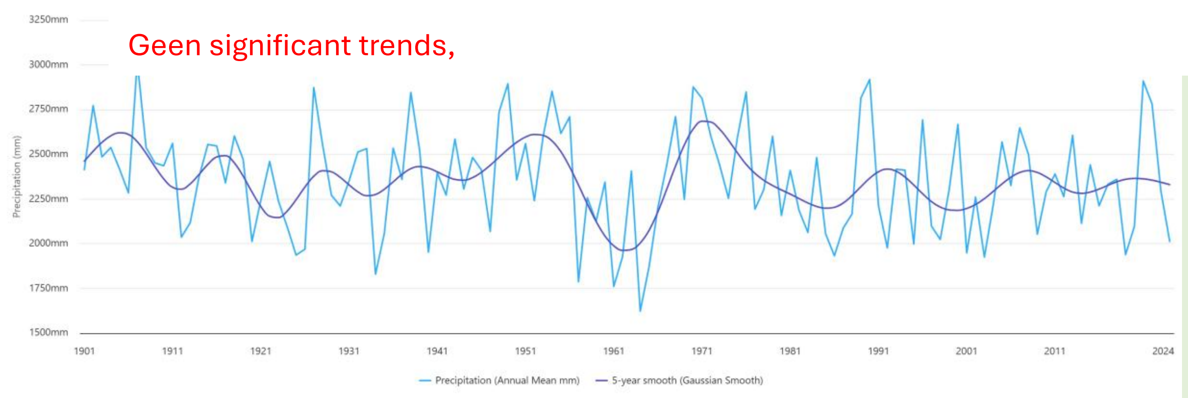
Gemiddelde temperatuur in Suriname 1900 – 2024
(https://climateknowledgeportal.worldbank.org/)

Stijging van gemiddelde temperatuur van 0.5 tot 0.75 ^oC sinds 1990



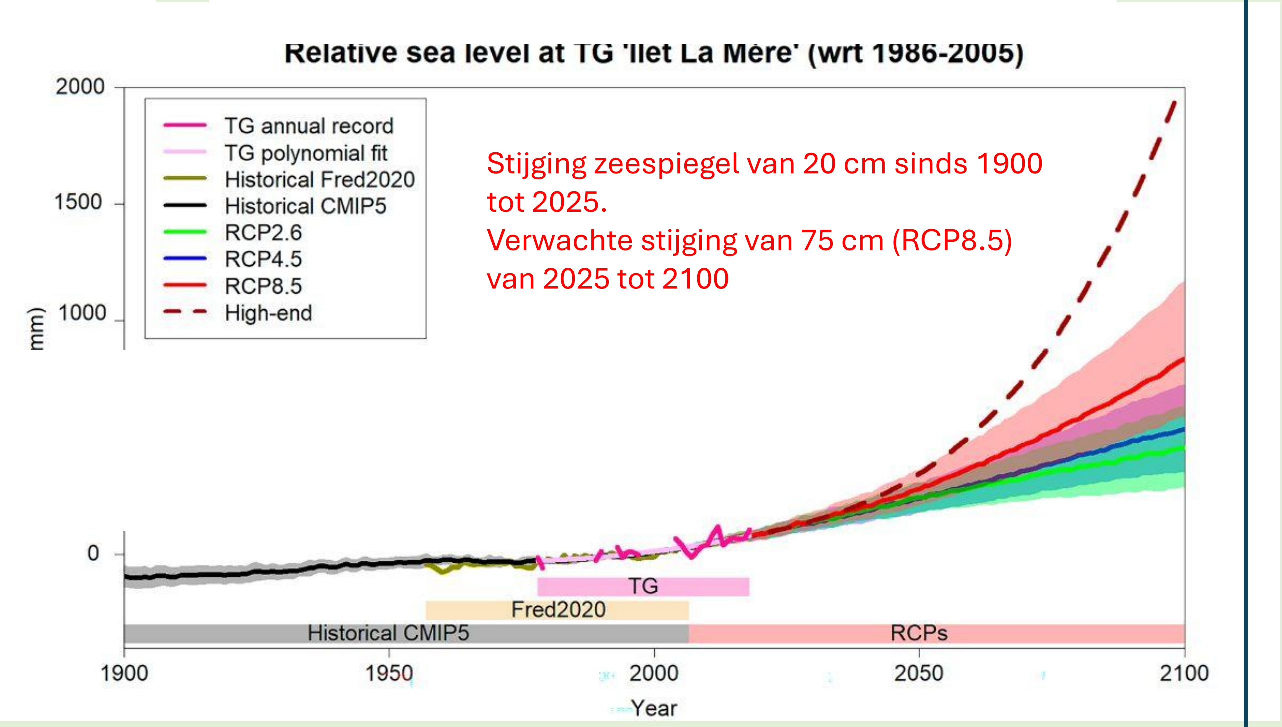
Gemiddelde jaarlijkse neerslag in Suriname 1900 – 2024
(https://climateknowledgeportal.worldbank.org/)

Geen significant trends,



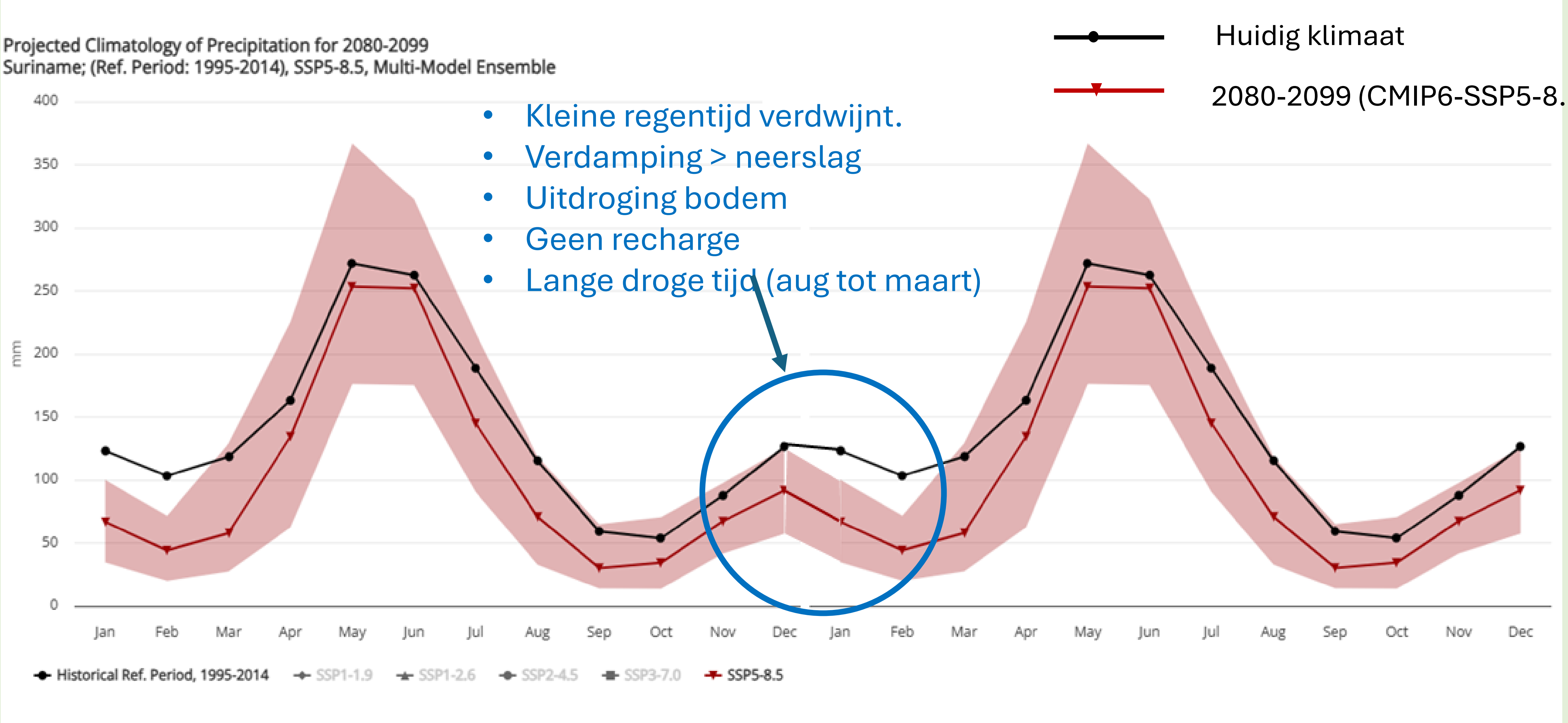
Zeespiegelstijging Frans Guiana 1900 – 2100
Thiéblemont et al, 2023

Stijging zeespiegel van 20 cm sinds 1900 tot 2025.
Verwachte stijging van 75 cm (RCP8.5) van 2025 tot 2100



ook in individuele neerslagstations geen trends (behalve Totness: afname neerslag)

Climate change



- Kleine regentijd verdwijnt.
- Verdamping > neerslag
- Uitdroging bodem
- Geen recharge
- Lange droge tijd (aug tot maart)

Resultaten Fase 2 (klimaat)

Effecten droogtes

Compartiment	Hydrolog. Effect	Afgeleid hydr. Effect	Milieueffect (Sector)
Oppervlakte water	• Dalende waterstanden • Opdrogen rivieren en zwampen		• Langere afstand tot water (Drinkwater binnenland) • Bevaarbaarheid problemen (Transport binnenland, Toerisme) • Schade natuur ecosystemen (Ecosystemen, Toerisme) • Afname peil en instroom Brokopondo (Energie)
	• Stagnatie en afname doorstroming meren en zwampen	• Indamping • Stilstaand water • Eutrofiering	• Chem. Verontreiniging (Volksgezondheid) • Ziekteverwekkend organ. (Volksgezondheid) • Schade natuur (Ecosystemen, Toerisme)
	• Afname baseflows in droge tijd in kustvlakte	• Intrusie van zout in rivieren	• Beperking inname zoet water (Irrigatie, Drinkwater, Overige gebruikers)
Bodemvocht	• Uitdroging, toename zuigspanning		• Gewasschade (Landbouw) • Schade natuur (Ecosystemen, Toerisme)
Grondwater	• Minder of geen recharge • Daling grondwaterstanden		• Droogvallen ondiepe putten • Mogelijk tijdelijke afname capaciteit diepe putten (Drinkwater & Overige gebruikers) • Afname berging

Waterbehoefte en productie

Master plan 2011

Water behoefte gebaseerd op:

- huishoudelijk100 tot 200 l/p/d
- 5 tot 30 % van huishoudelijk voor industrie
- 5 tot 15 % voor institutioneel
- lijkt overschat. Huidige productie SWM is veel lager

- Behoefte stabilizeert als NRW verlies vermindert met ca 10 %

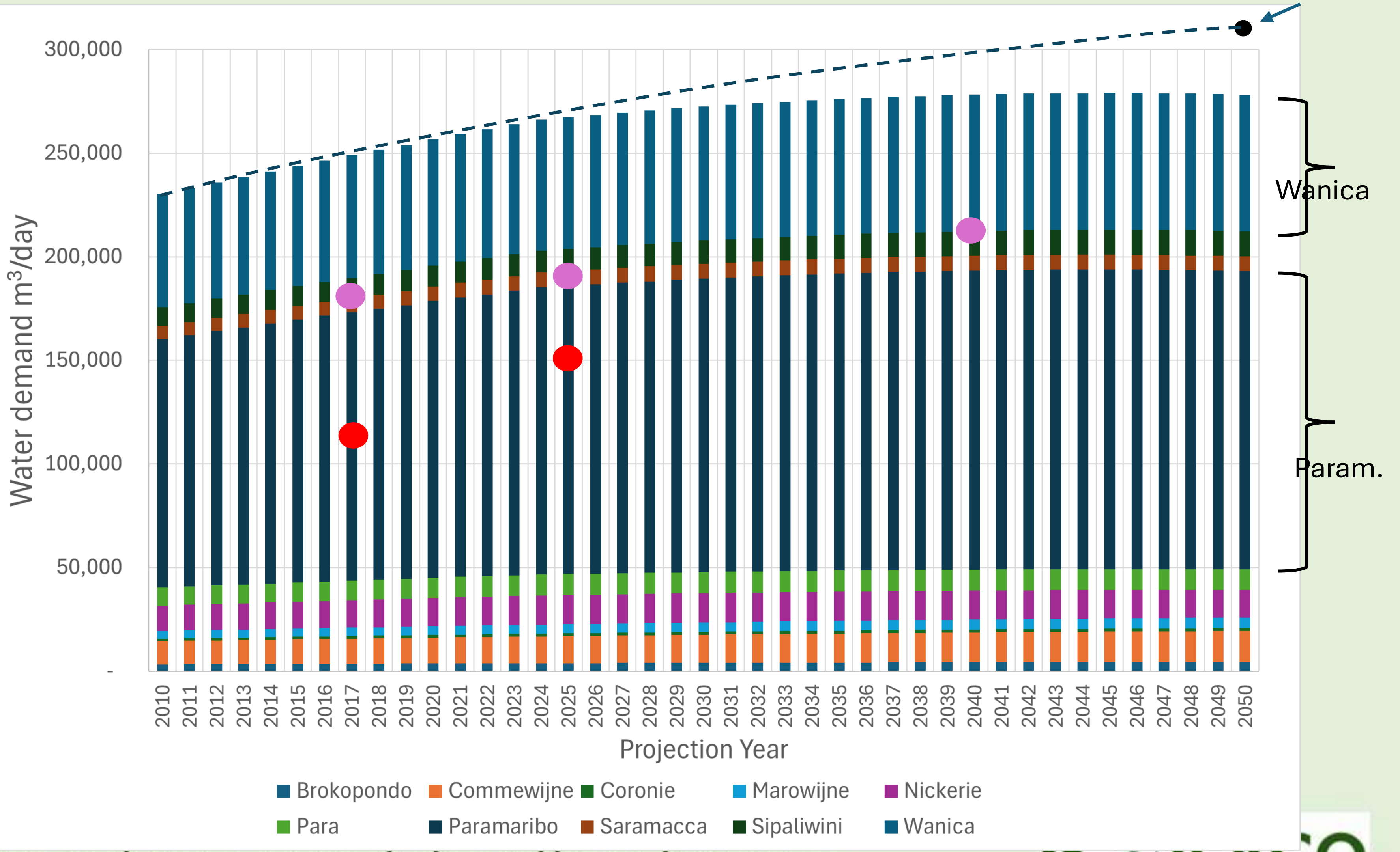
Hacas, 2016

Water behoefte gebaseerd op:

- Huishoudelijk 200 l/p/d
- 22% van huishoudelijk voor industrie
- 7 % van huishoudelijk voor institutioneel
- Met industrial park ontwikkeling
- NRW verlies

SWM Productie

Inclusief NRW waterverlies



Waterbehoefte en productie

Conclusies

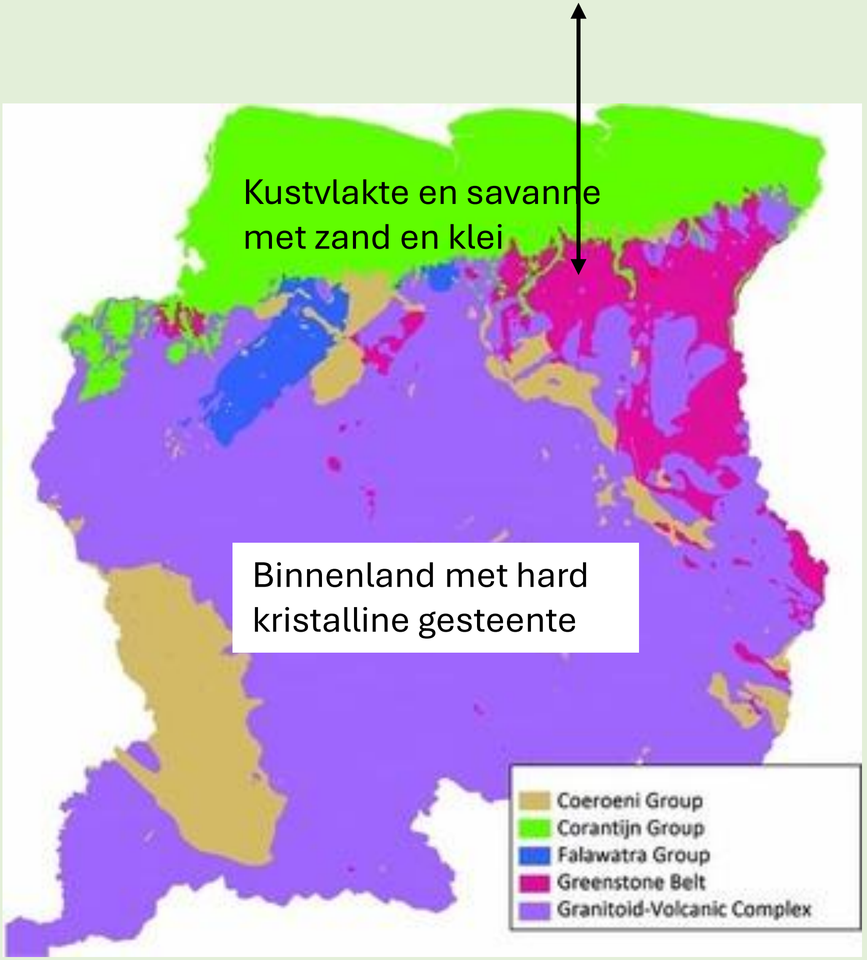
- In 2040 productietekort van 65000 m3/dag: ca 40 % van huidige SWM capaciteit

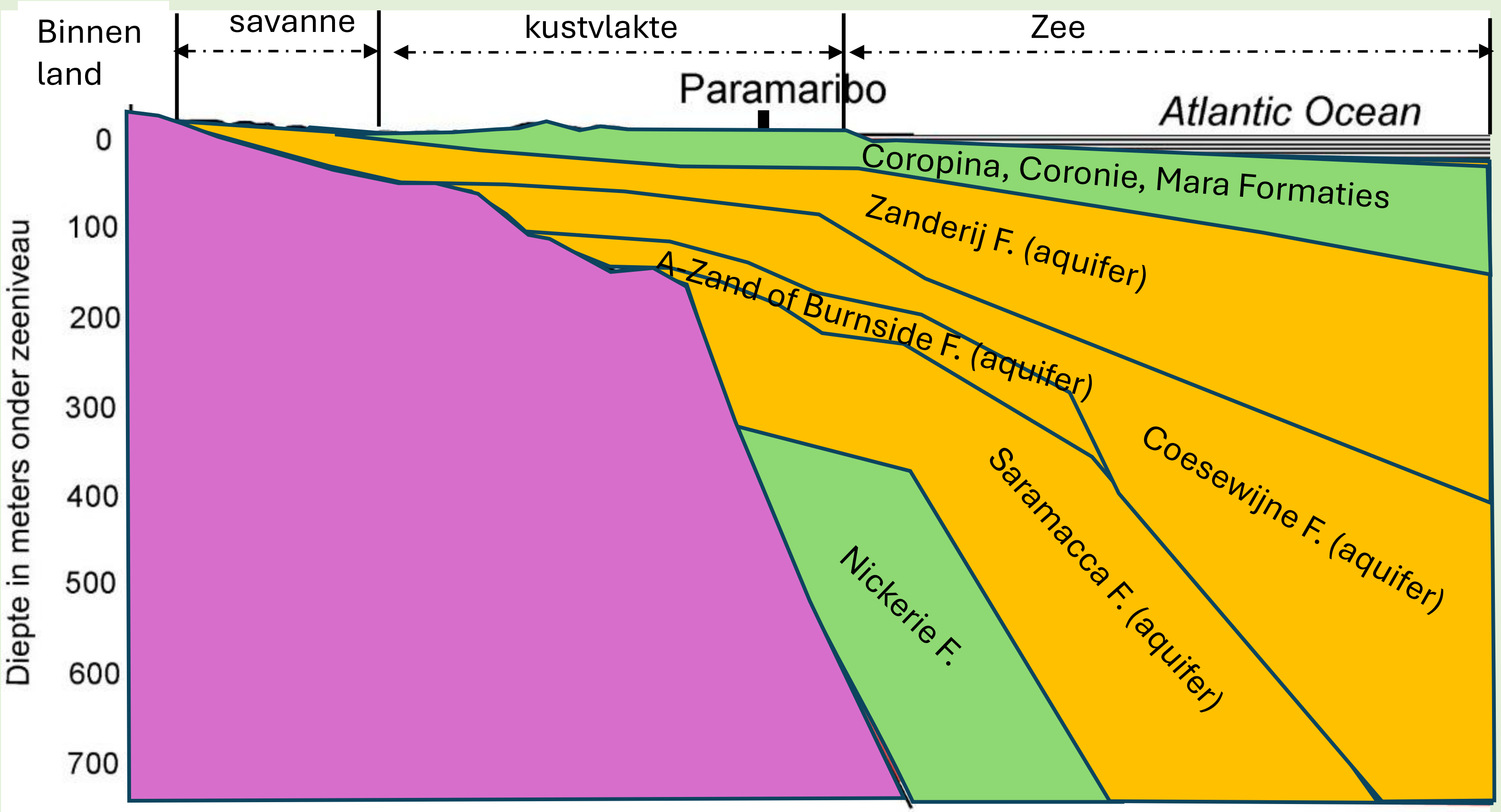
- In 2040 productietekort van 112000 m3/dag als stations met brak water moeten worden vervangen: ca 70 % van huidige SWM capaciteit
  - 37.000 m3/dag brak water in Paramaribo
  - 10.000 m3/dag brak water in Nickerie)

(NB getallen gelden voor huishoudelijke + industriele watervoorziening)

HACAS (2016) beschrijft mogelijkheden voor nieuwe pompstations ten zuiden van Paramaribo

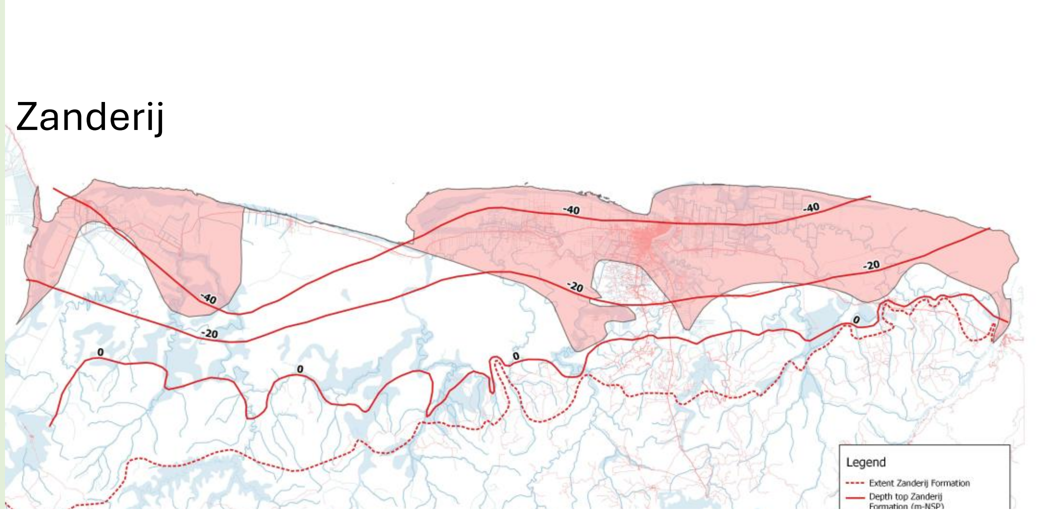
Aquifers

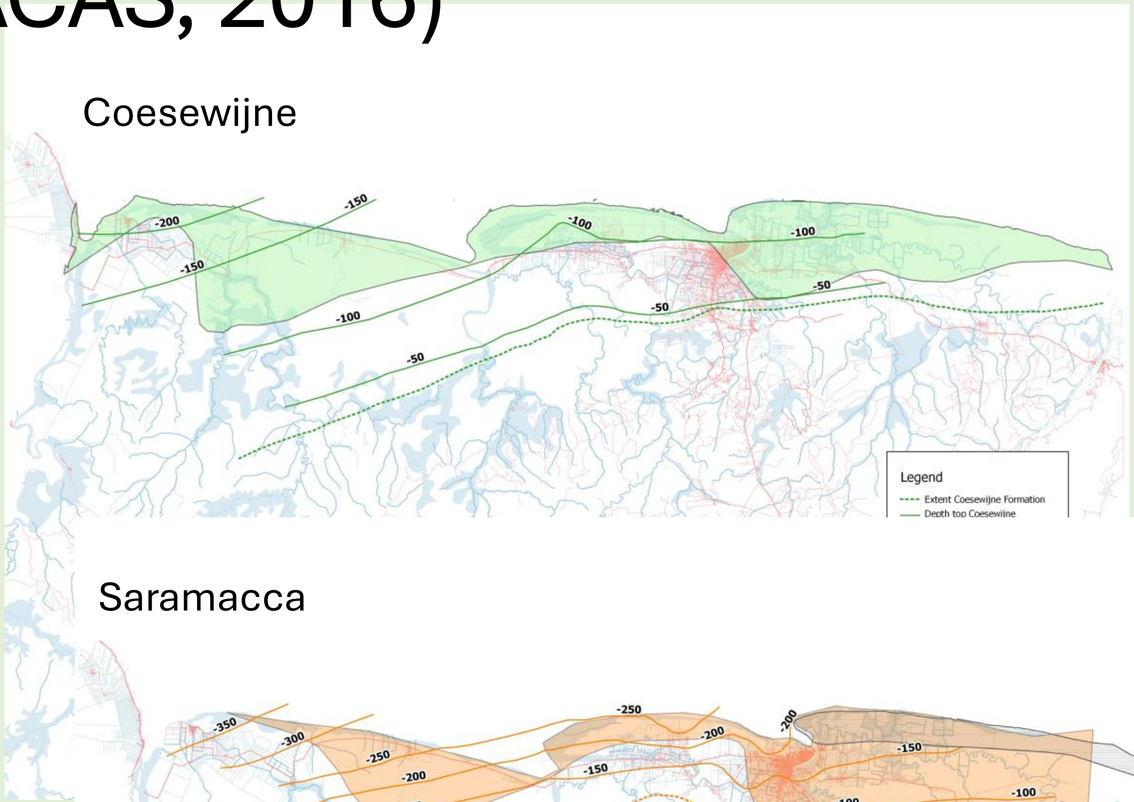


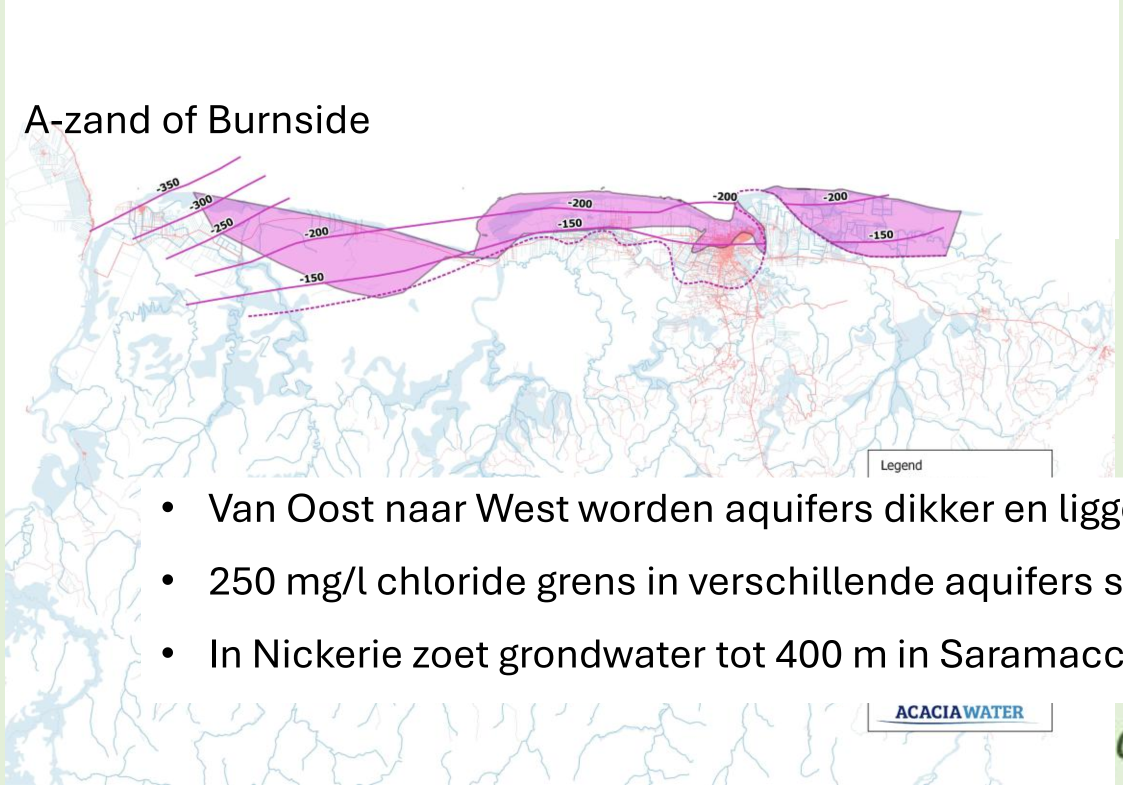


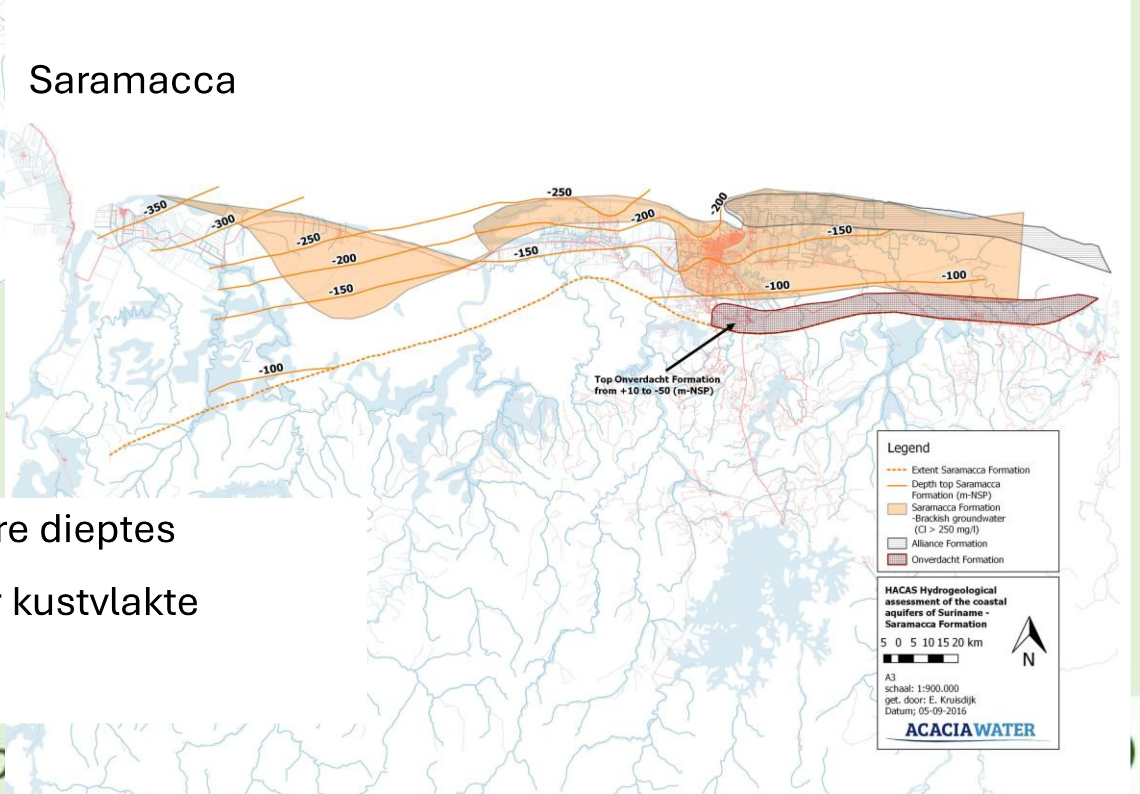
- Aquifers in kustvlakte bevatten fossiel zoet grondwater, geen recharge
- Richting kust neemt zoutgehalte toe in aquifers van kustvlakte.
- Alleen in Savanne gebieden recharge van Zanderij aquifer

Aquifers (HACAS, 2016)









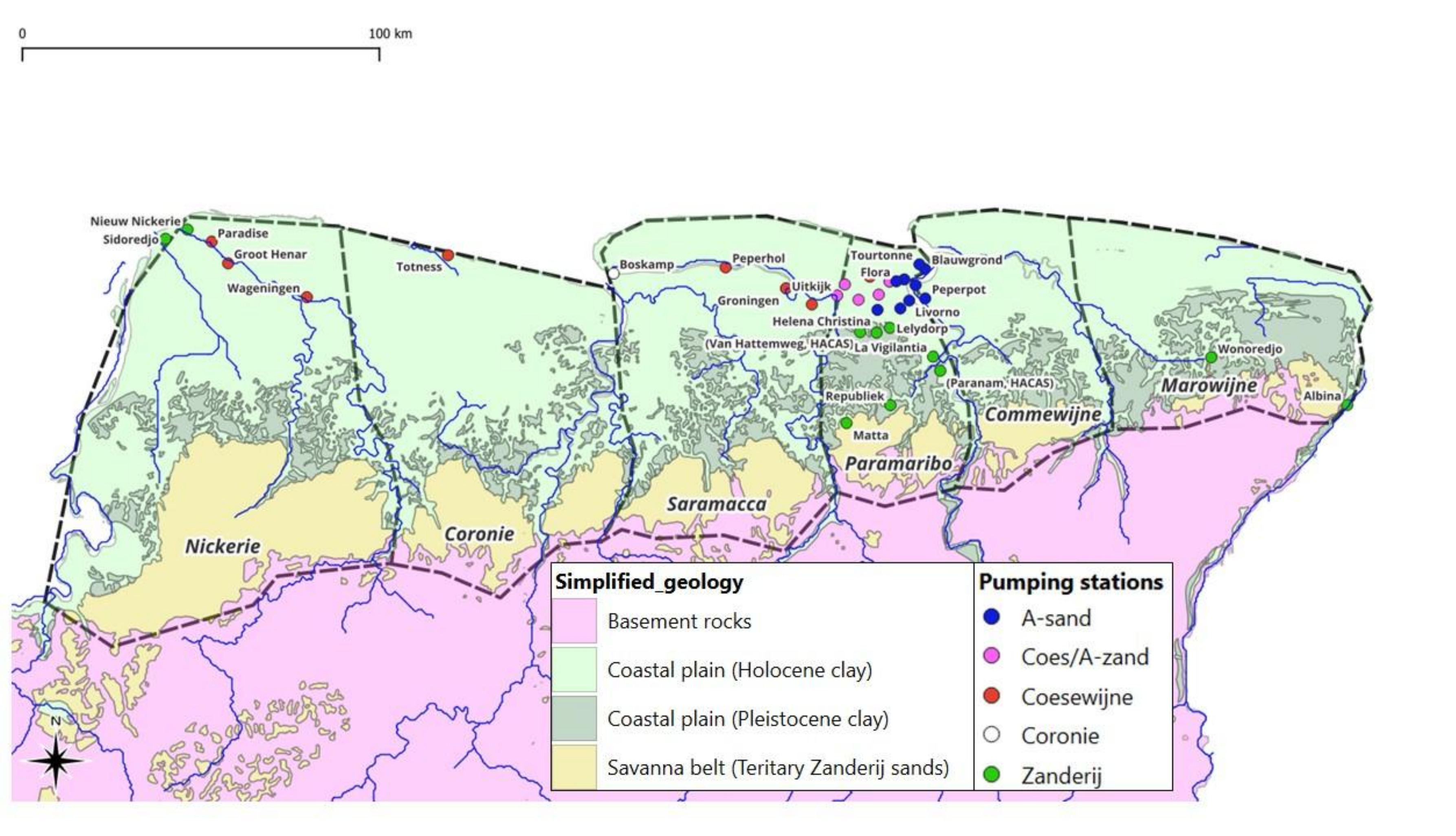
- Van Oost naar West worden aquifers dikker en liggen op grotere dieptes
- 250 mg/l chloride grens in verschillende aquifers slingert door kustvlakte
- In Nickerie zoet grondwater tot 400 m in Saramacca aquifer

Waterbalansen

6 waterbalans gebieden in kustvlakte en savanne

Aanname: duurzame winning:

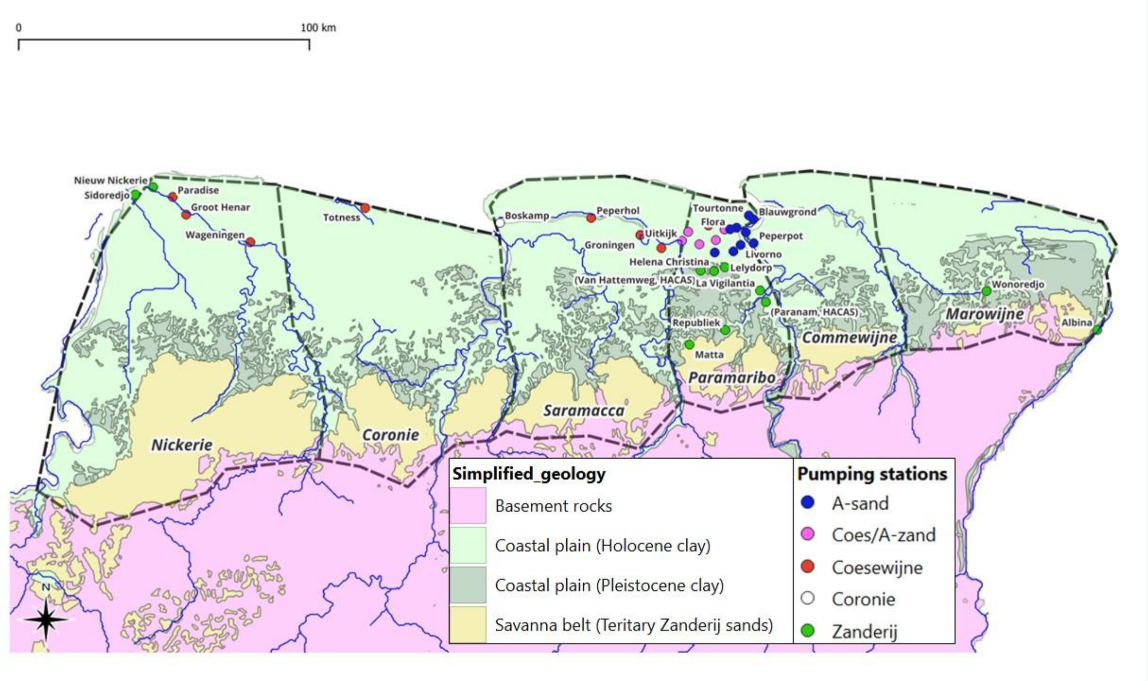
- 20 % van voeding van Zanderij aquifer in savannegebied
- 40 % van hoeveelheid in fossiele aquifers



Aquifers en Waterbalansen

Conclusies

- **Algemeen**
  - Aquifers ongevoelig voor droogtes en klimaatsverandering (behalve ritsen).
- **Marowijne, Saramacca, Coronie en Nickerie**
  - Overal zoet water in een van aquifers. Voor eeuwen voldoende.
- **Commewijne**
  - brak grondwater in alle aquifers behalve ritsen.
  - (Nu opp. water uit La Liberte)
- **Paramaribo**
  - Voldoende water tot eind deze eeuw
  - Wel nieuwe pompstations nodig ten zuiden van Paramaribo (HACAS, 2016)
  - Daarna water uit 1) MAR of 2) Saramacca

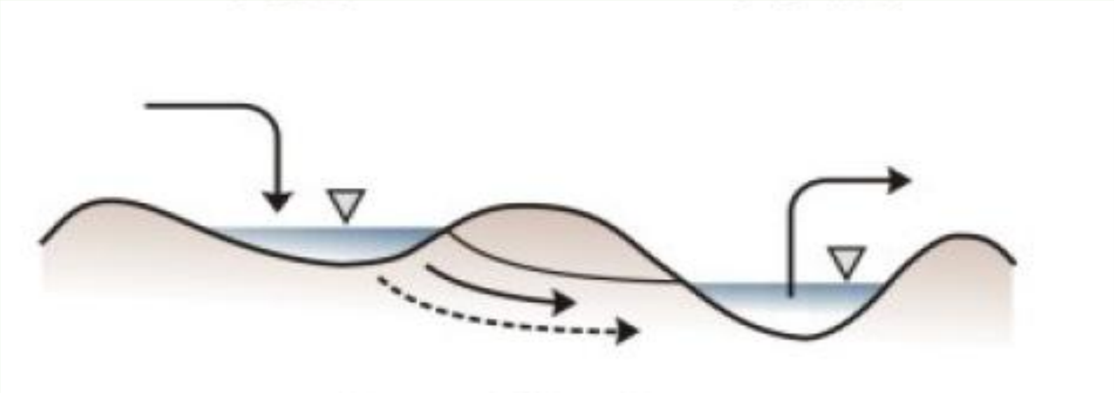


Haalbaarheid MAR in Suriname

Doelen Managed Aquifer Recharge

Voor de watervoorziening:

1. Opslag gevolgd door hergebruik bij watertekort
2. Opslag voor waterkwaliteitsverbetering (afbraak, adsorptie, afvlakken pieken,



Voor regionaal waterbeheer:

3. Opslag tegen overstromingen (afvlakken van afvoerpieken)
4. Opslag voor handhaving van hydrol. omstandigheden (tegengaan daling grondwaterstanden, verzilting, bodemdaling, afname basisafvoer

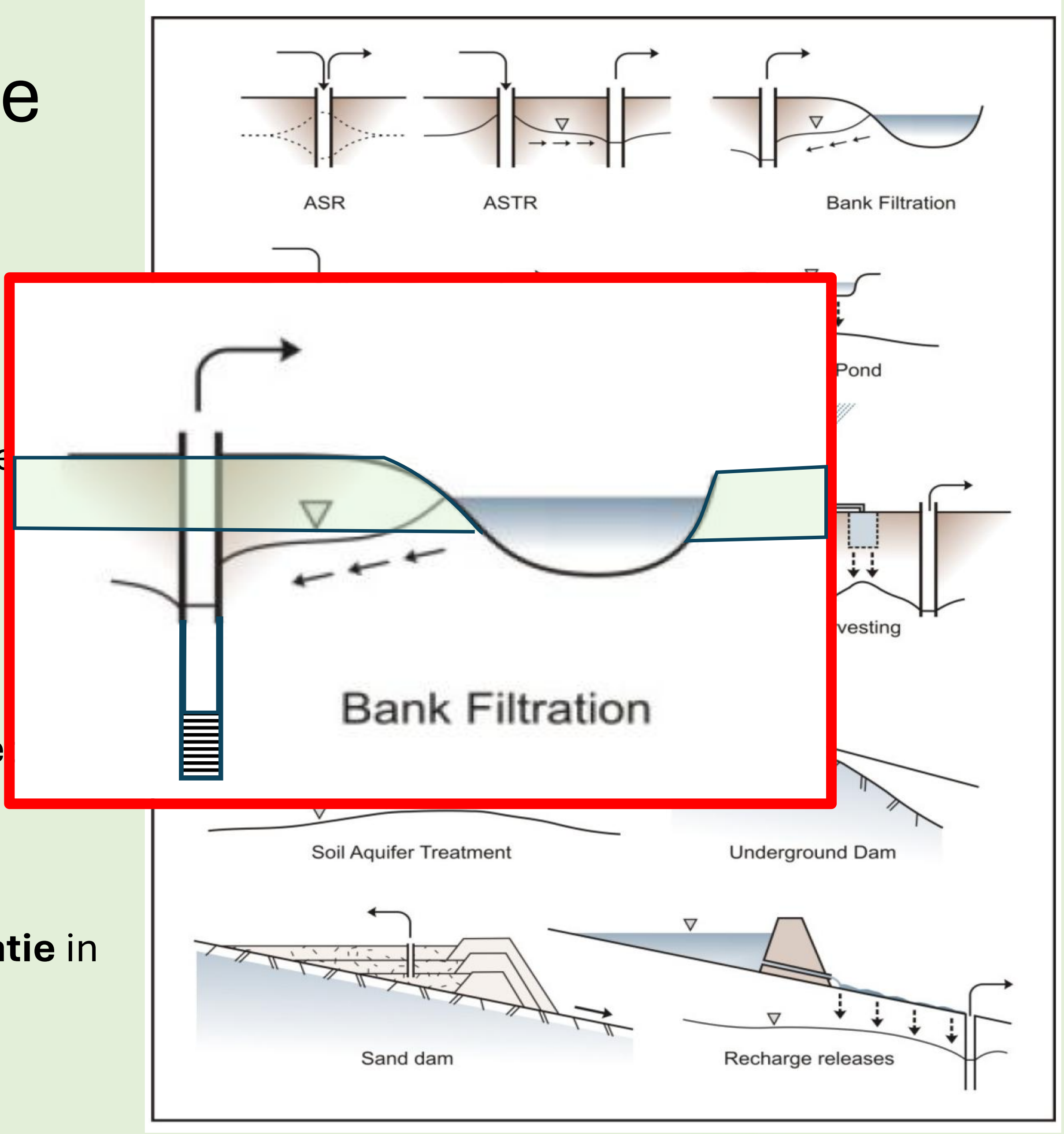
Haalbaarheid MAR in Suriname

MAR technieken

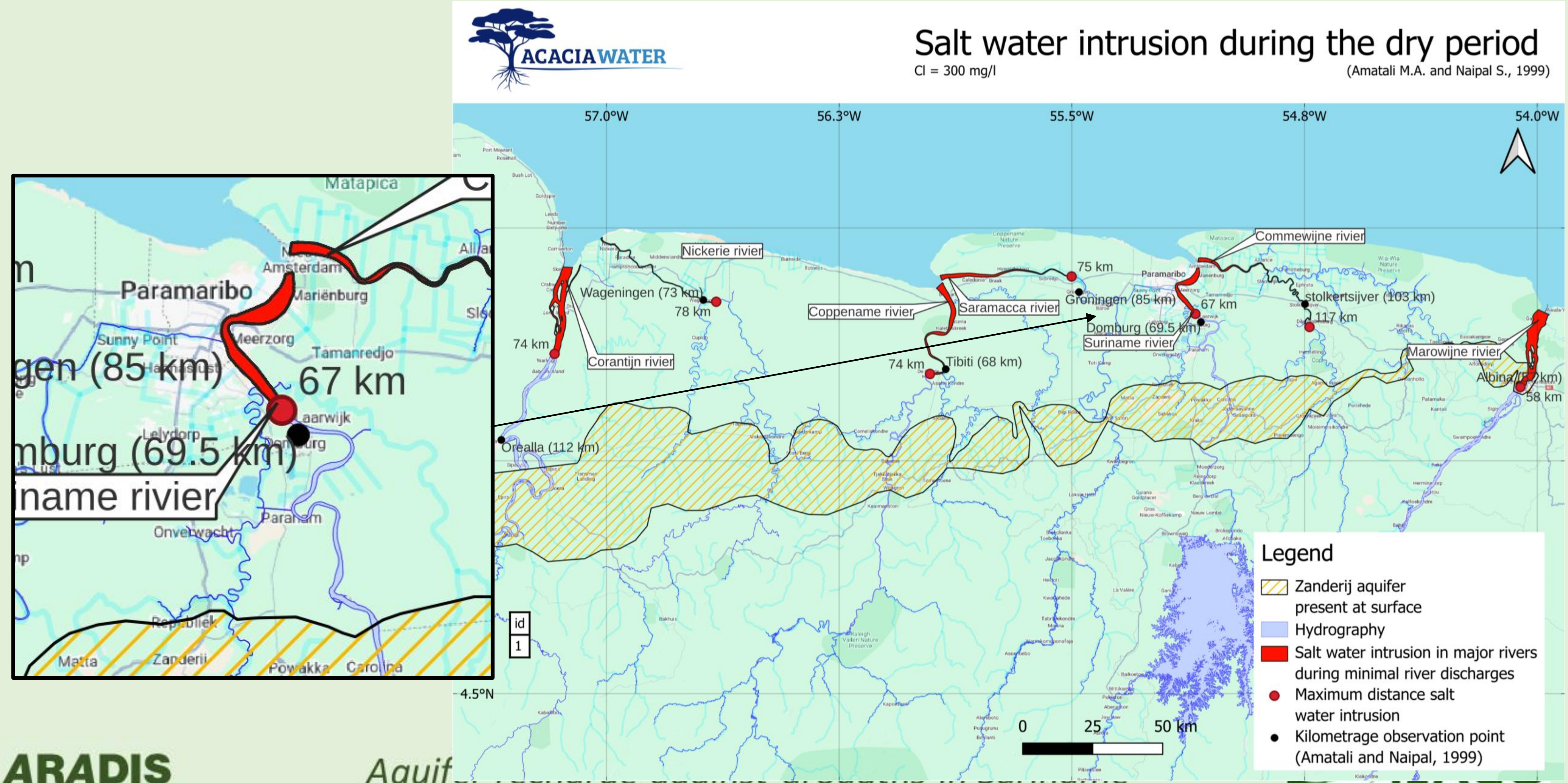
- Recharge via injectie door putten
- Recharge via wegzijging uit aangelegde bassins
- Recharge via wegzijging uit reservoirs achter dammen
- Recharge via opgewekte wegzijging uit nat. oppervlaktewate
  (oeverinfiltratie of bank infiltration)

Mogelijkheden Suriname

- Vanwege dike kleilagen in kustvlakte alleen MAR door injectieputten. Kostbaar door aanvoer, voorzuivering en inje
- Vanwege hoge grondwaterstanden reservoirs, dammen en dammen weinig berging mogelijk in savanne
- Meest geeigende MAR techniek in Suriname is **oeverinfiltratie** in gebieden met 1) dunne kleilagen en (hydraulisch contact oppervlaktewater en aquifers) en 2) buiten bereik zeewater.



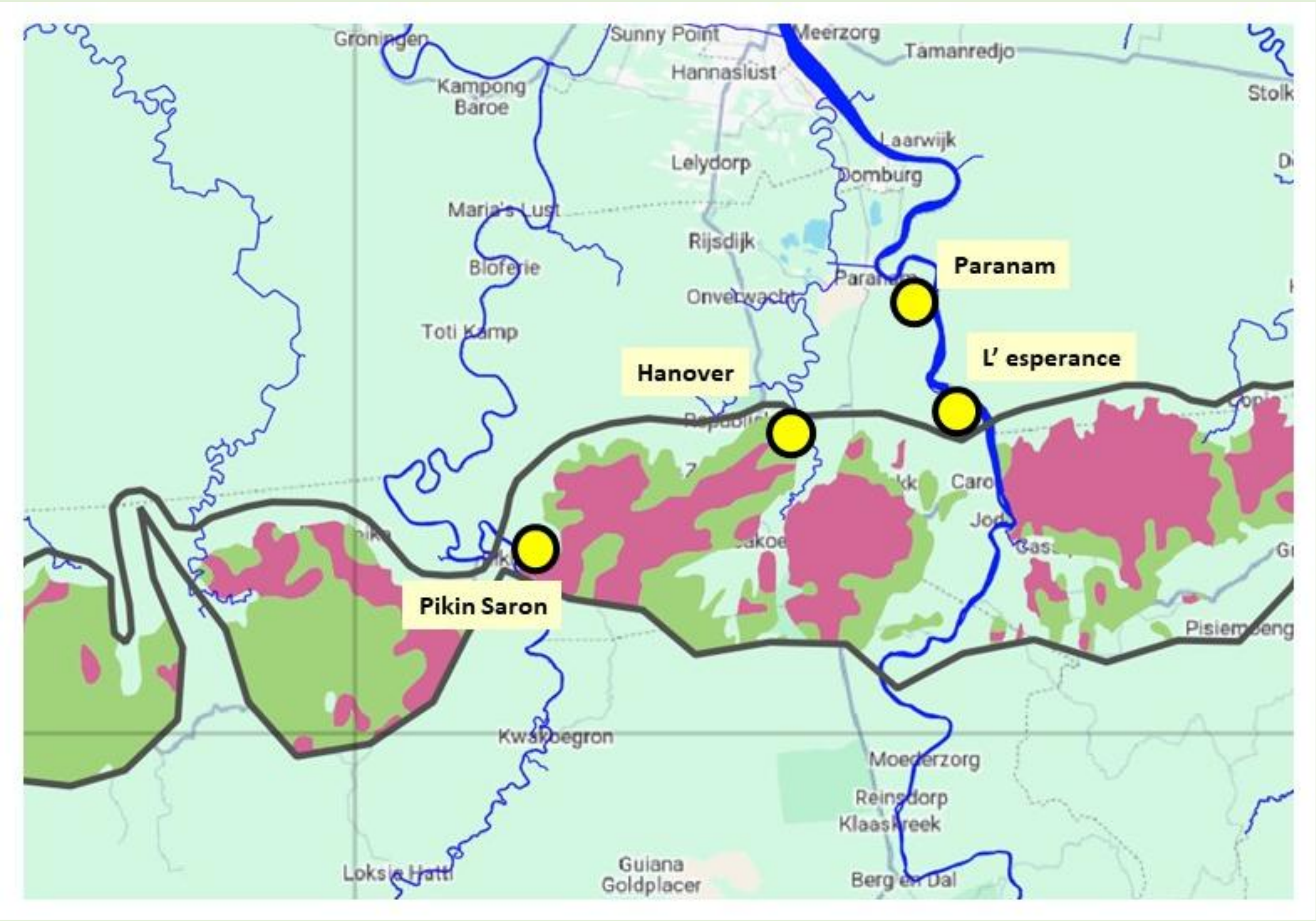
Zoutintrusie Rivieren



5 potentiele MAR sites

5 potentiele locaties:

- Hanover bij Para kreek,
- Pikin Saron bij Saramacca Rivier,
- L’Esperance bij Suriname Rivier
- Paranam bij Suriname Rivier
- SURALCO mijnmeren bij Lelydorp
- (Zandritsen)



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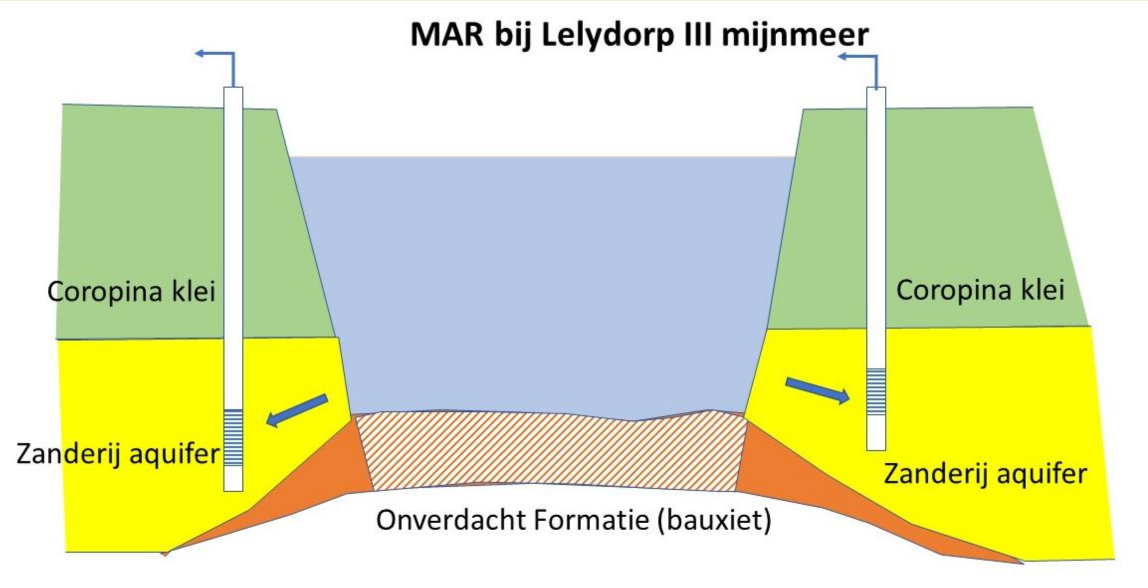
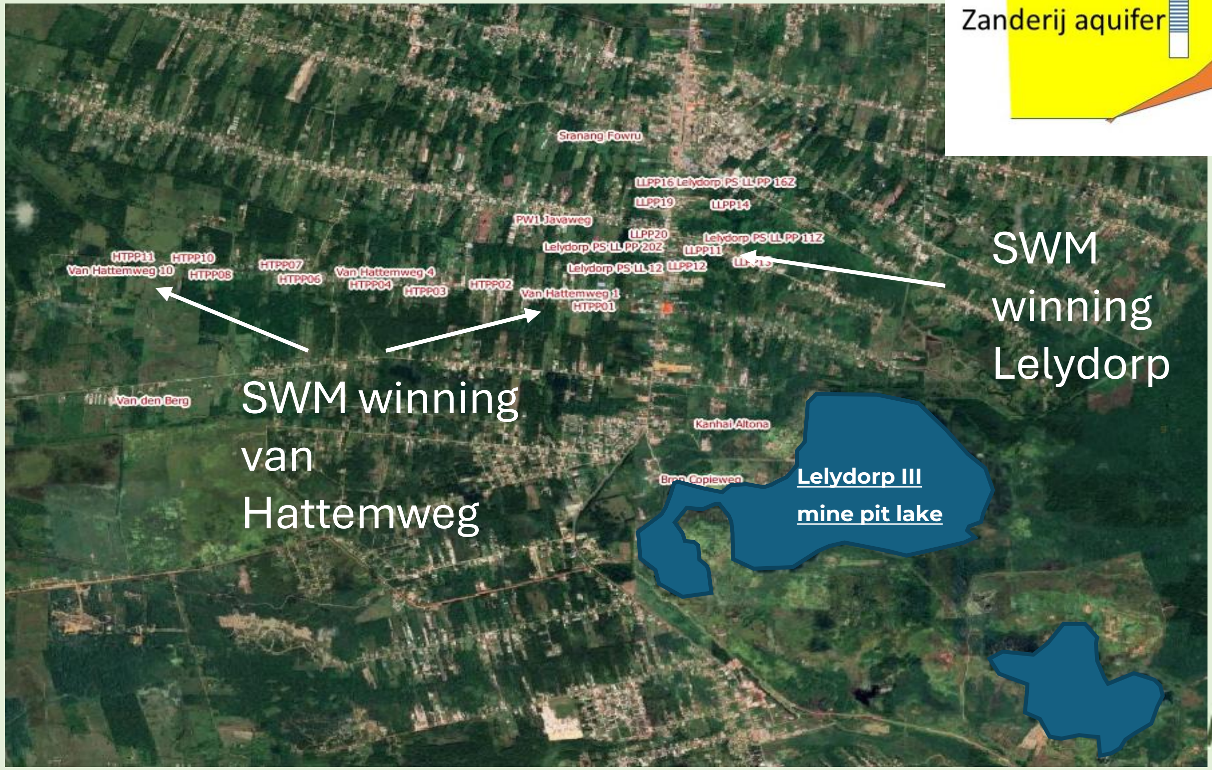




ARADIS
ILACO

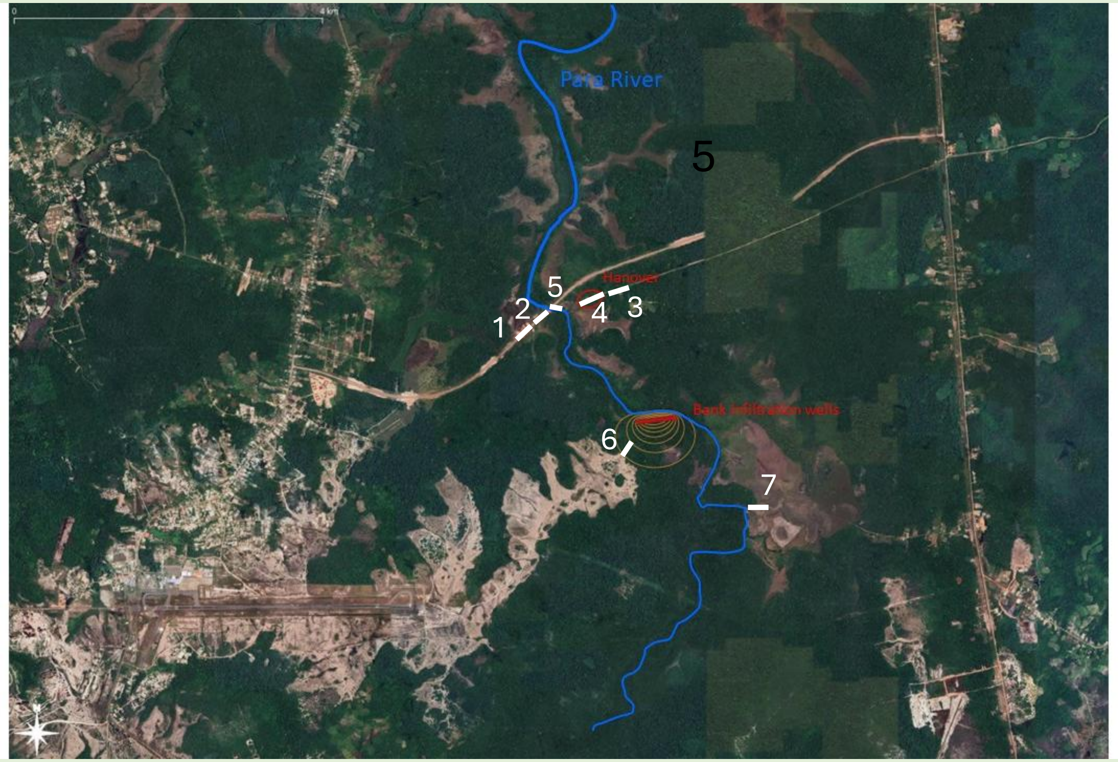
Hanover pilot MAR

Keuze SWG voor Hanover vanwege:

- Verwachte goede waterkwaliteit (als Republiek)
- Verwachte afwezigheid verontreinigingen
- Beschermbaarheid van bodem en catchment
- Watervoorziening voor locale gemeenschap

Fase 3: Ontwerp pilot MAR

Geofysische onderzoek Hanover

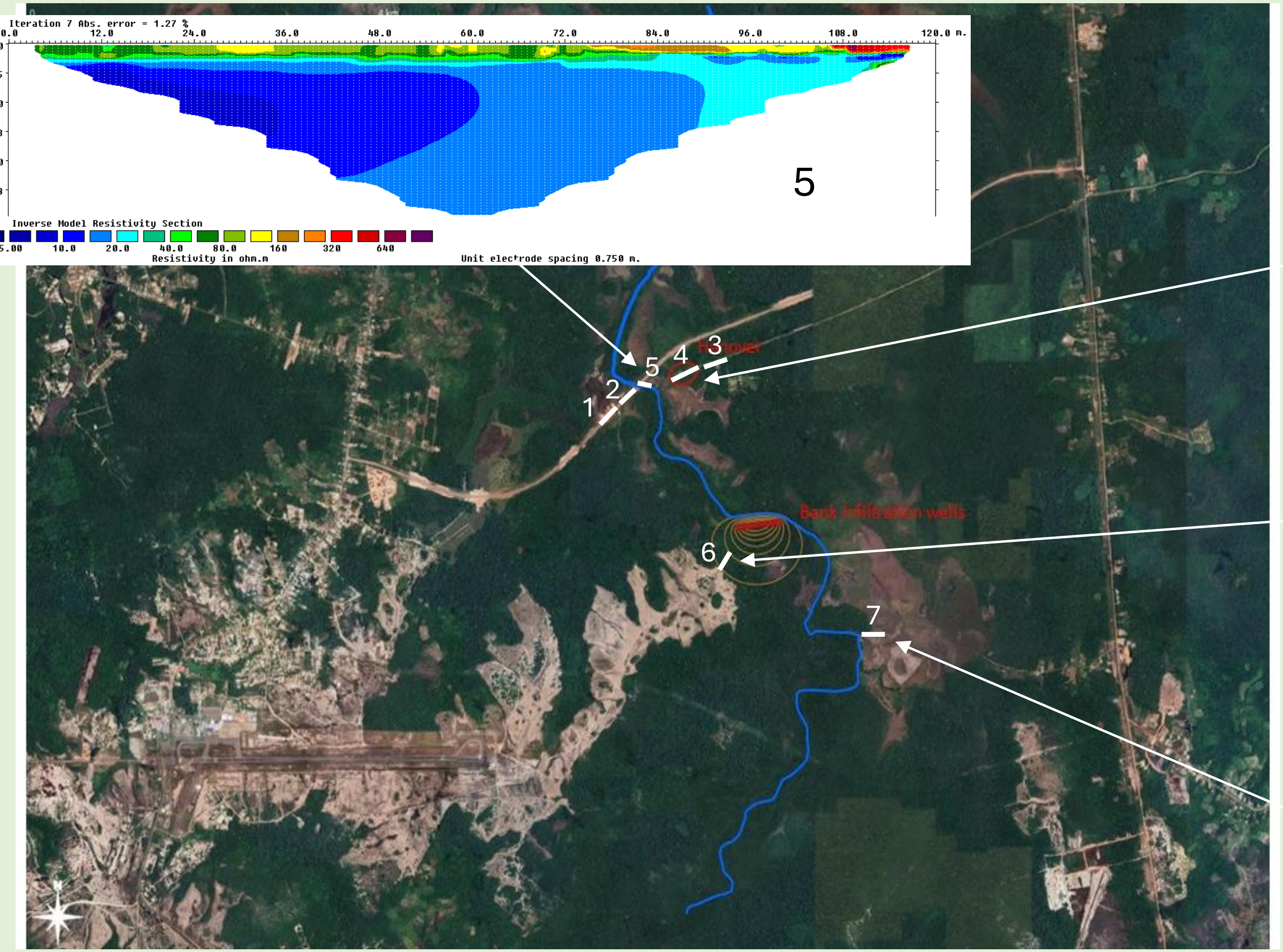


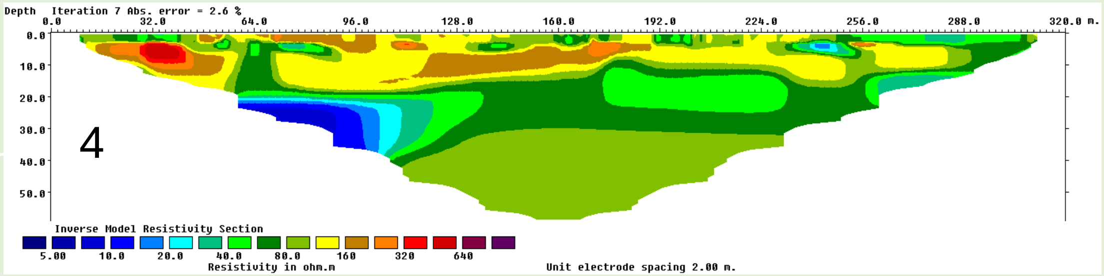
Vraagstelling

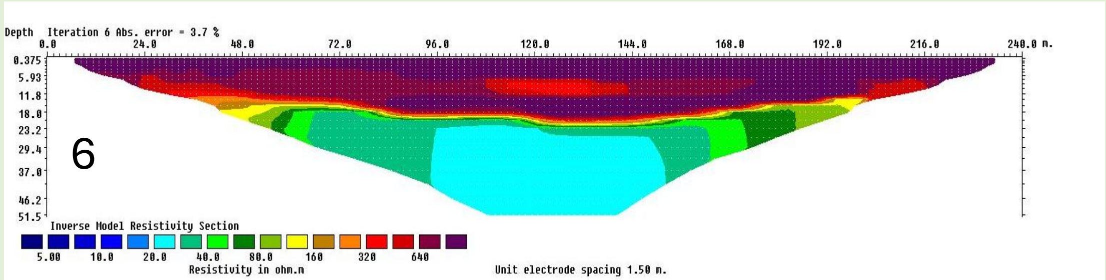
- Waar is de Zanderij aquifer met voldoende dikte (> 10 m) ?
- Is er hydraulisch contact tussen Zanderij aquifer en Para Kreek ?

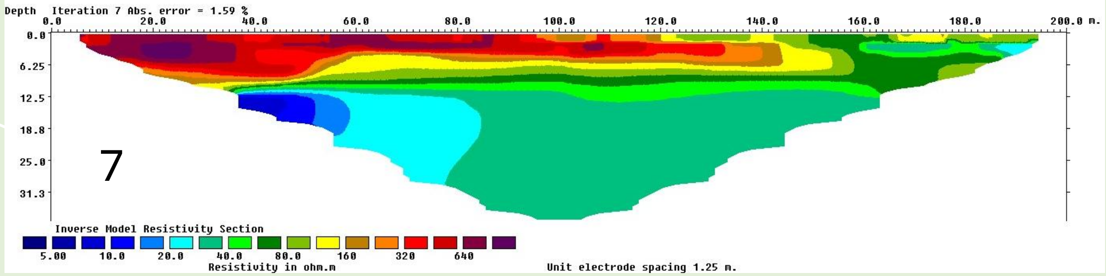
Geofysisch onderzoek Hanover

Homogeen zand met zoet water: > 240 Ohmm (oranje - rood)
Klei en kaolinite: < 60 Ohmm (blauw - licht groen)

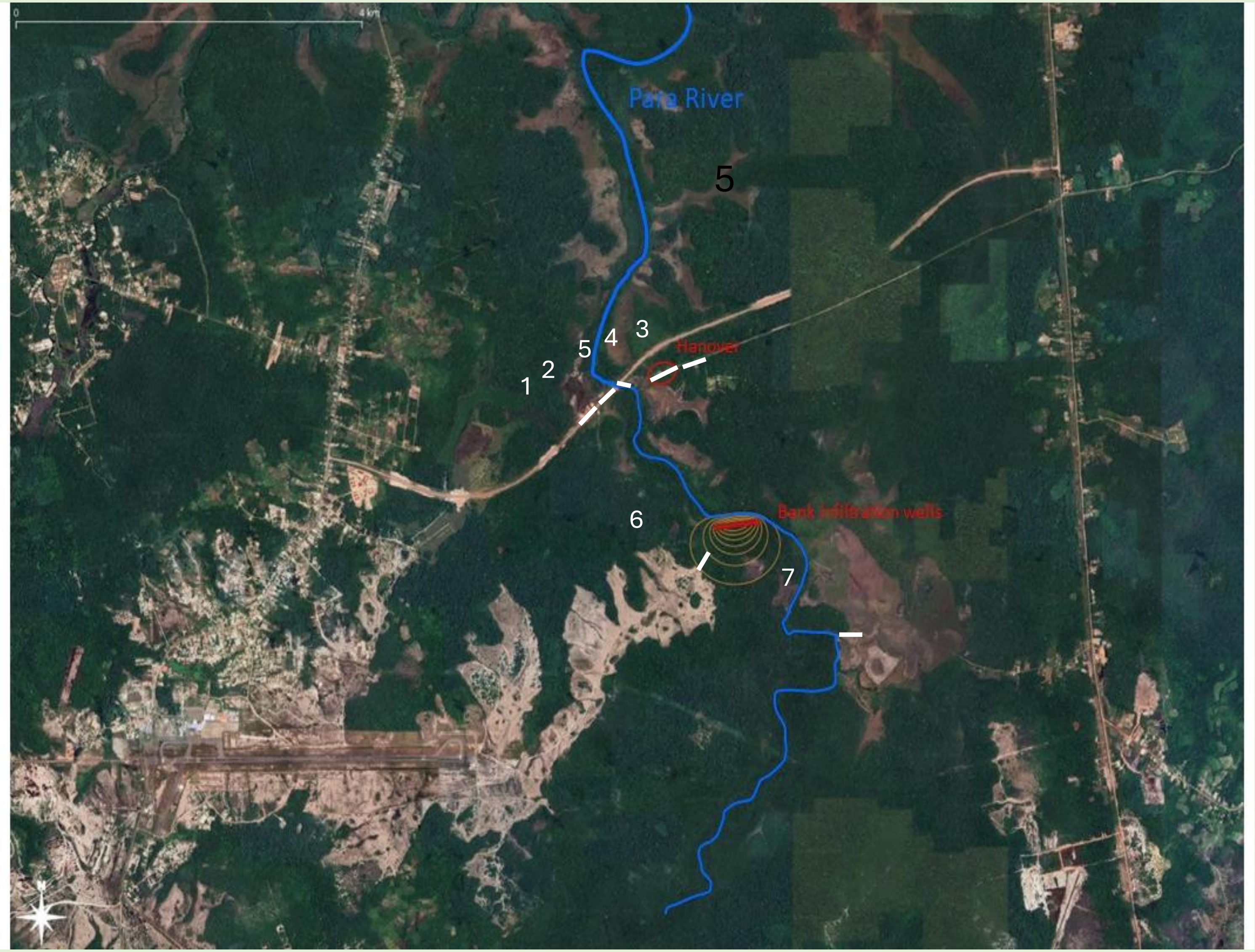








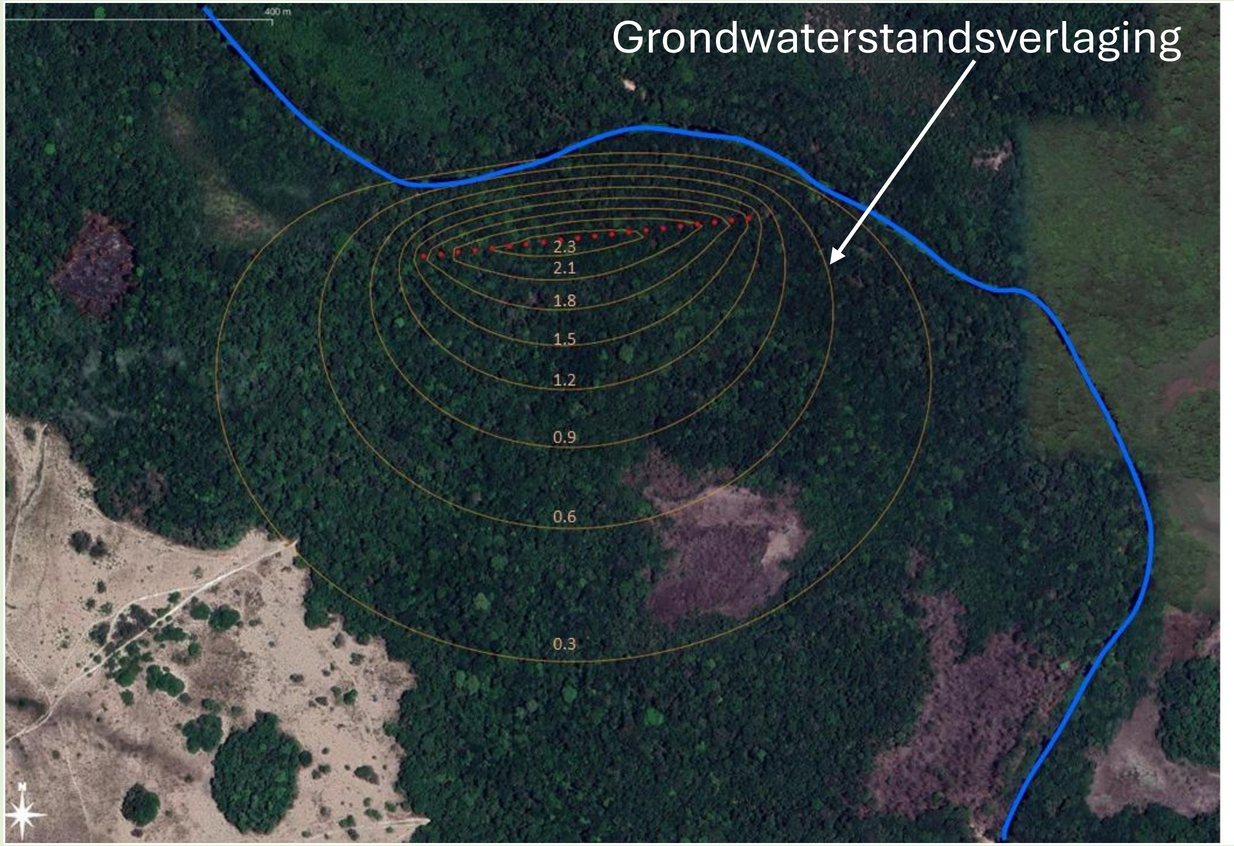
Geofysisch onderzoek Hanover

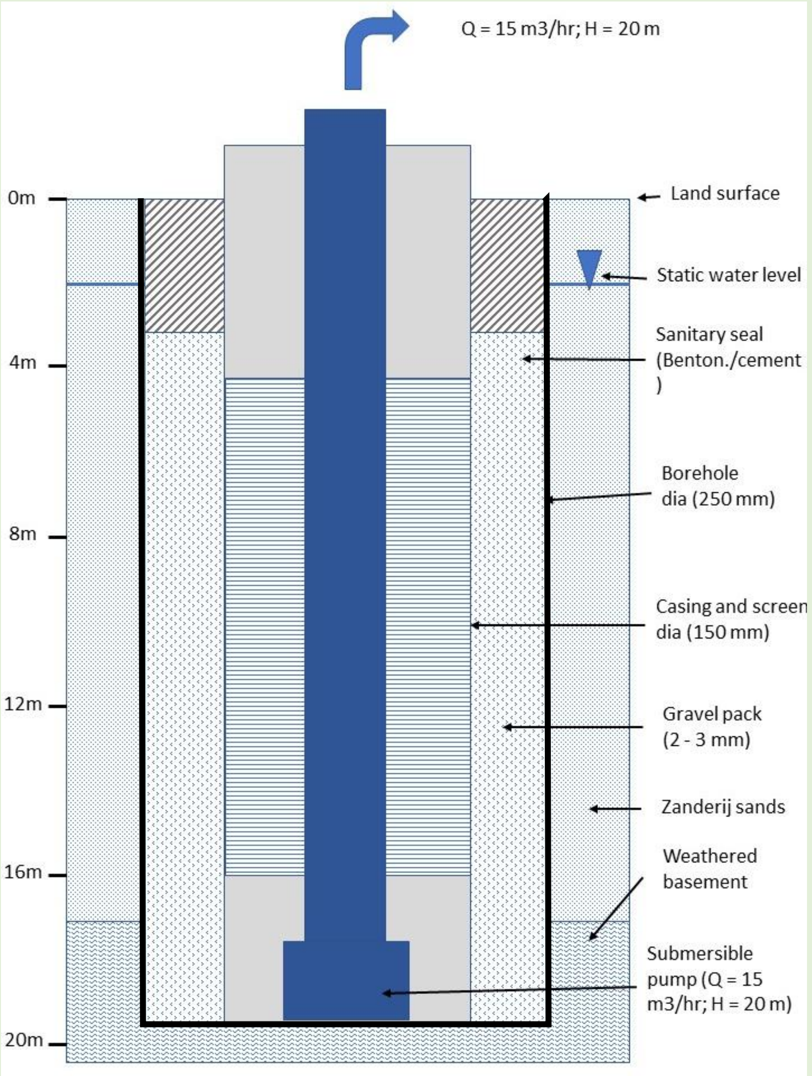


Conclusies

- Bij Hanover is kreekdal opgevuld met (Mara) klei (zie meting 5)
- Bij meting 6 en 7 Zanderij > 10 m en reikt tot Para kreek. Bodem kreek bestaat daar uit zand
- Locatie 6 meting vanwege toegankelijkheid meest geschikt (verder onderzoek)

Ontwerp pilot MAR Hanover (put en puttenveld)

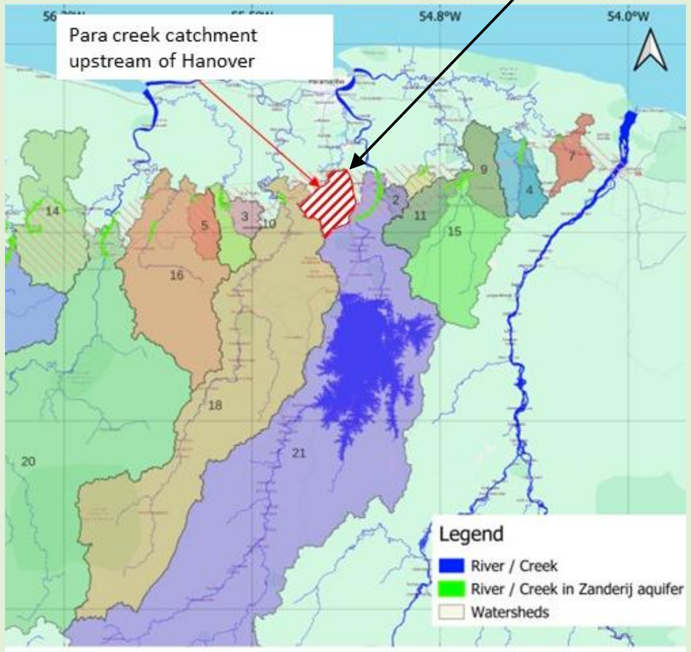




- Rij van 20 putten (afstanden 25 m, putcapaciteit 15 m3/hr, total 300 m3/hr)
- Puttenrij 100 m afstand tot rivier
- Verlagingen maximaal 2.5 m bij putten
- Verblijftijden van grondwater van Para naar putten: 30 dagen

Bescherming grond- en oppervlaktewater Hanover pilot

- Waterwingebied 30 dagen verblijftijd (nieuwe wet)
- Beschermingszone I en II 25 jaar verblijftijd (nieuwe wet)
- Ook bescherming nodig van Para catchment

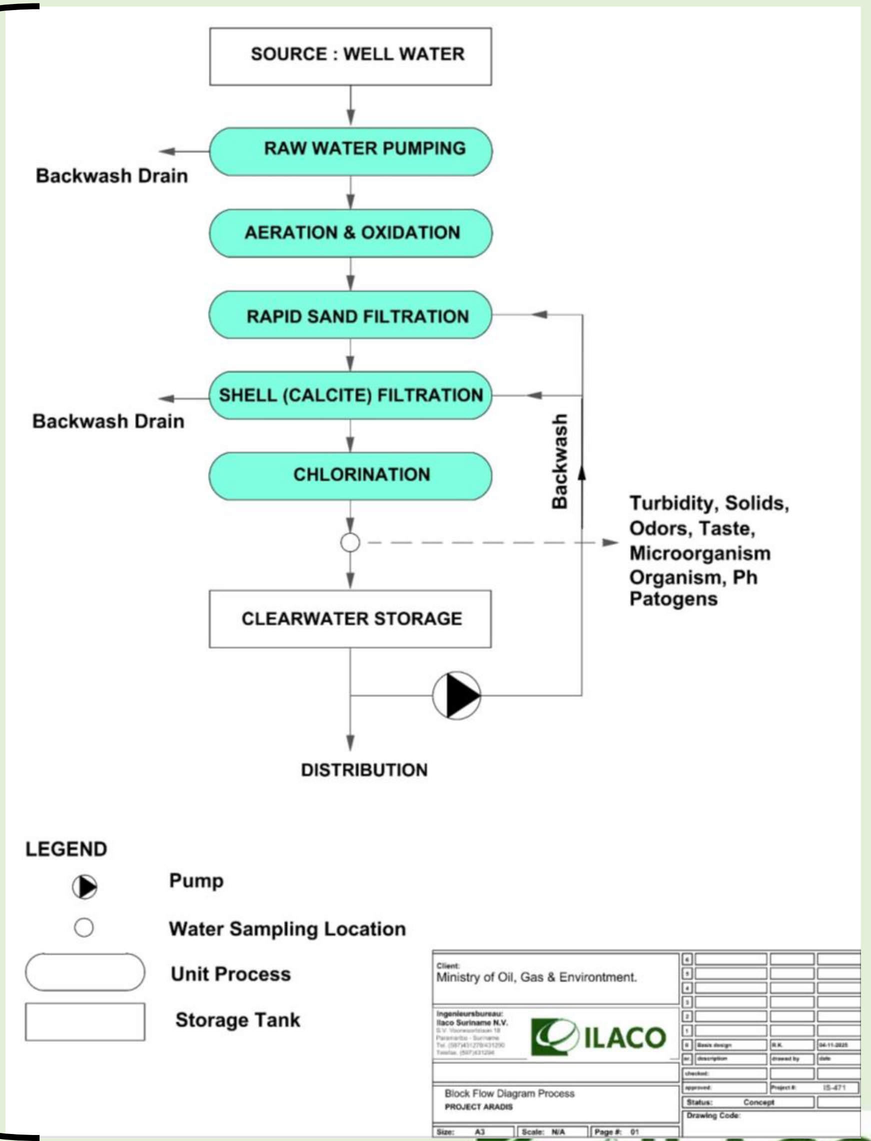


Water kwaliteit en behandeling Hanover pilot

- Analyses
  - Dit onderzoek Hanover put (niet betrouwbaar), Para kreek
  - Analyses uit andere onderzoeken Zanderij aquifer m.n Republiek

- Grondwater kwaliteit vergelijkbaar met Republiek
  - Belangrijkste kenmerken
  - Weinig gemineraliseerd (soort Spa water, 7 – 26 mg/l Cl)
  - Zuur (pH 4.8 – 5.4, veel CO_2)
  - Zacht water, weinig kalk (hardhead 0.6 – 5.5 mg/l)
  - IJzer houdend (0.6 tot 5.5 mg/l)

- Vereiste behandeling vergelijkbaar met Republiek



Nader onderzoek Hanover pilot

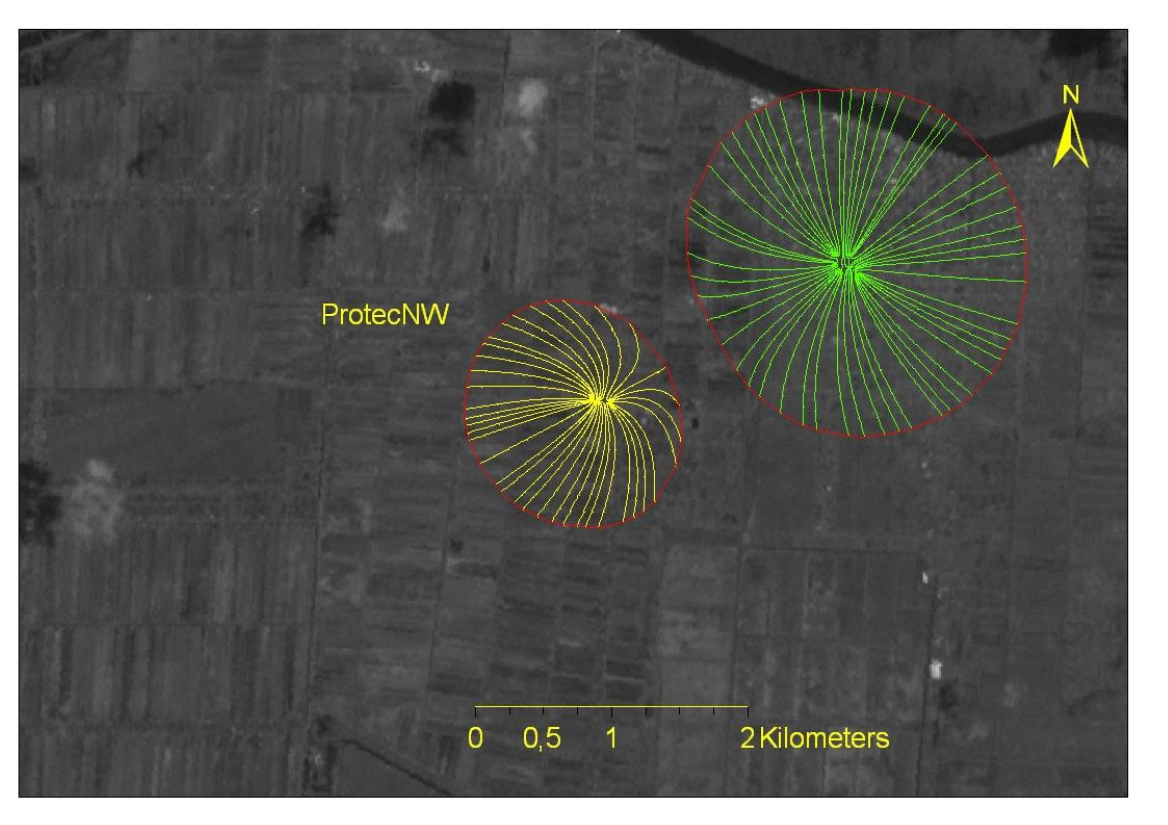
Voor detailontwerp nader onderzoek:

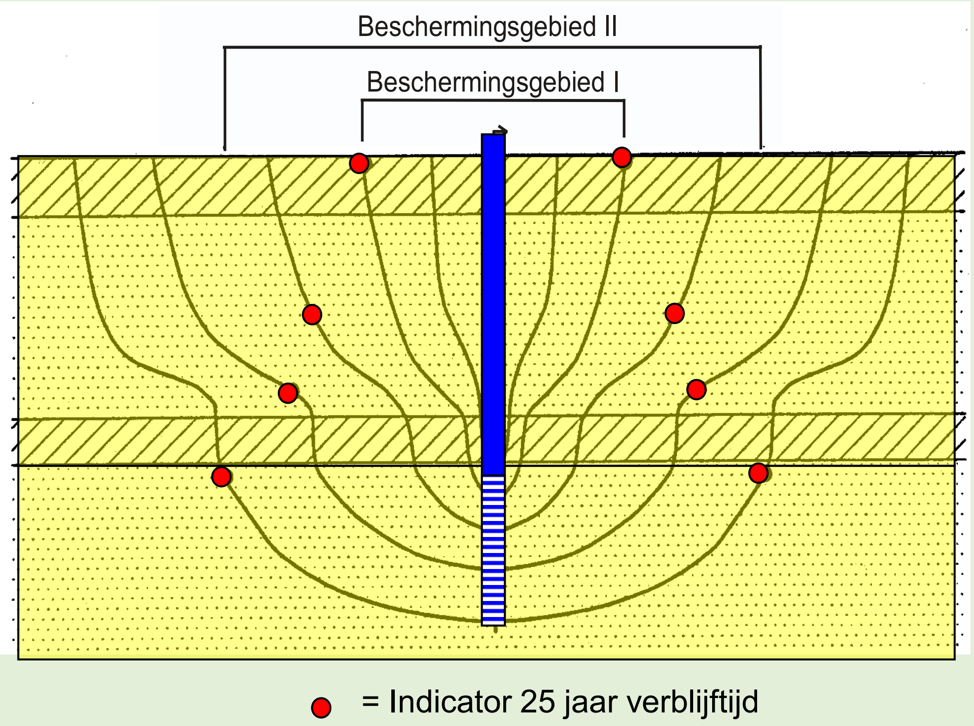
- Wie is mogelijke gebruiker en beheerder en wat zijn randvoorwaarden?
- Onderzoek landeigendom
- Meer geofysische exploratie voor definitieve locatie
- Proefboring, pomptest en chemische analyse
- Modelberekening voor ontwerp putten en vaststelling beschermingszones

Grondwater agenda in Suriname

1. Invoering van wetgeving op gebied van bodem- en grondwaterbescherming
2. Besparen grondwatergebruik (10 %) door terugdringen lekkages Non Revenue Water)
3. Ontwikkeling nieuwe pompstations ten zuiden van Paramaribo voor huishoudelijk grondwater (ca 100.000 m3/d)
4. Onderzoek naar mogelijkheden van ontzilting van grondwater voor Commewijne district (Solar/RO units van 300 tot 1500 m3/d)
5. Onderzoek naar mogelijkheden van winning van grondwater uit ritsen voor landbouw (PhD onderzoek Oclaya Verwey)
6. Onderzoek naar mogelijkheden van kleinschalige MAR nabij kreken en rivieren en binnenland (50 tot 3.000 m3/d)
7. Onderzoek grootschalige MAR bij Paranam (voor industriele ontwikkeling (24.000 m3/d)

Grondwaterbescherming





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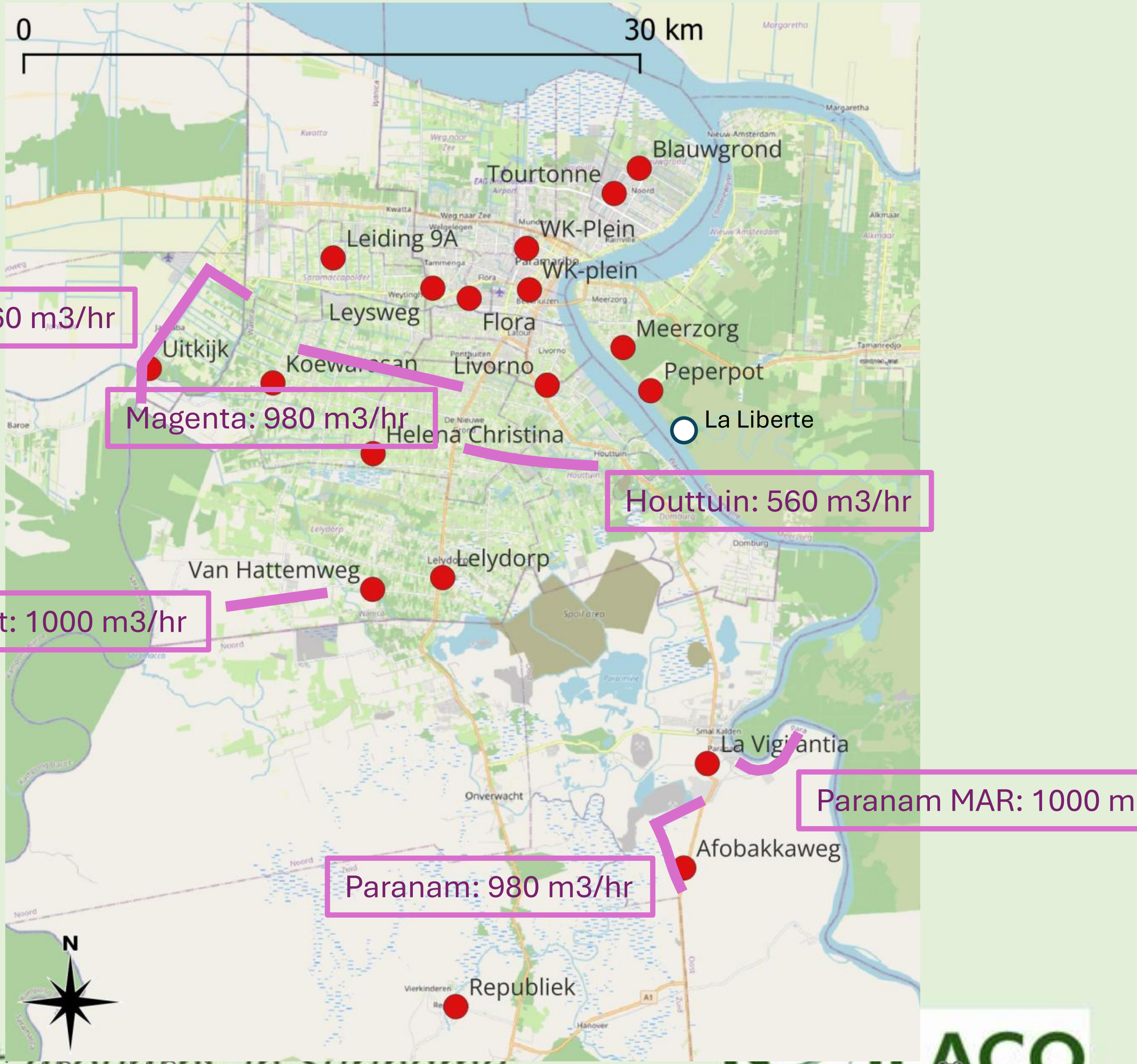
Mogelijke pompstations ten zuiden van Paramaribo

- Huidige productie Groot Paramaribo: 5.600 m3/hr (120.000 m3/d)
- Waarvan 27 % brak water
- Uitbreiding nieuwe stations: 4900 m3/hr (110.000 m3/d)



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7. Onderzoek naar mogelijkheden van kleinschalige MAR nabij kreken en rivieren en binnenland (50 tot 3.000 m3/d)

Internationaal Voorbeeld
Solar desalination in rural Africa

Kiunga, Kenya: 3300 inh., 75 m3/d

Kabatican, Kenya: 1500 inh., 7 m3/d

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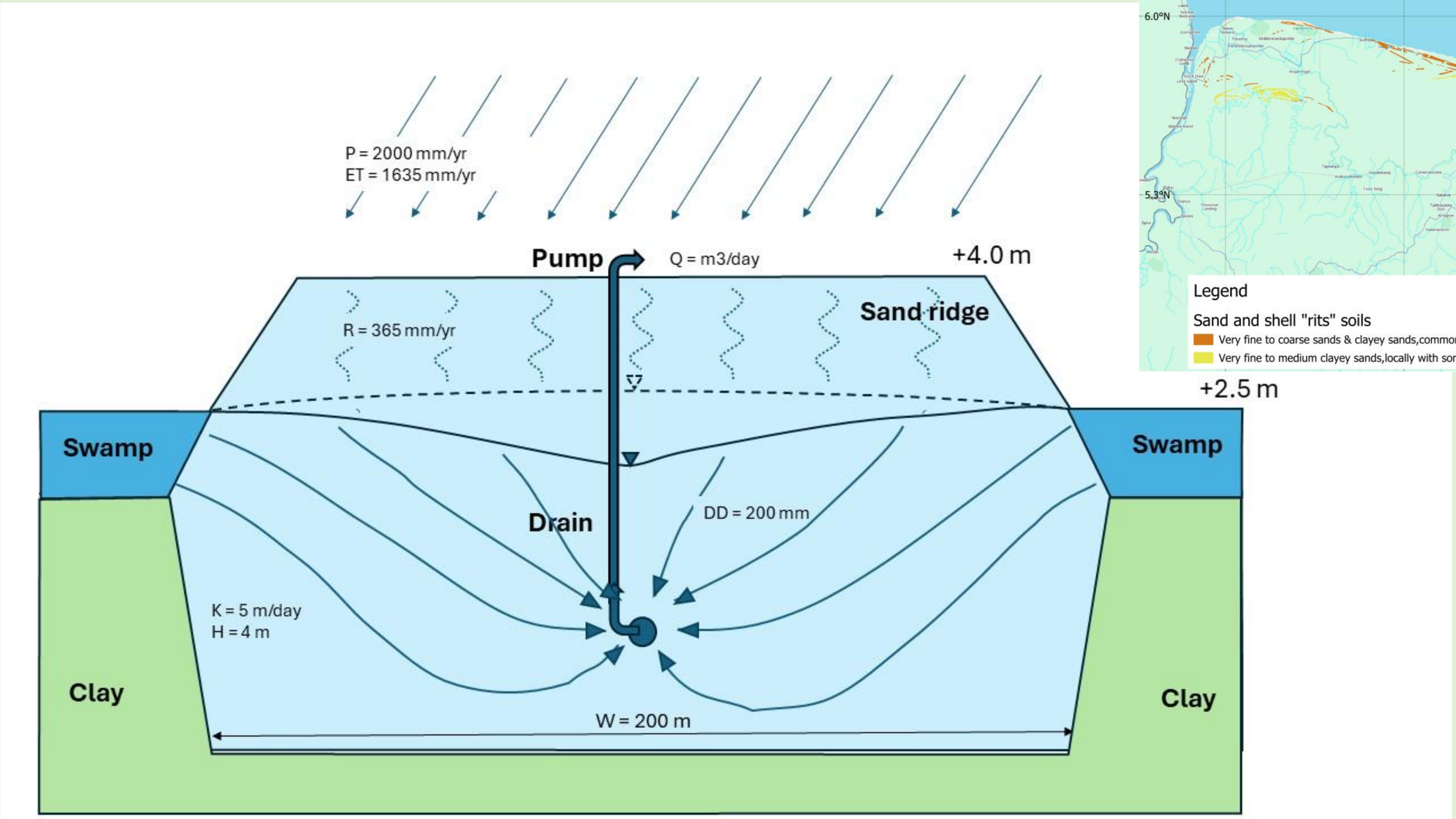
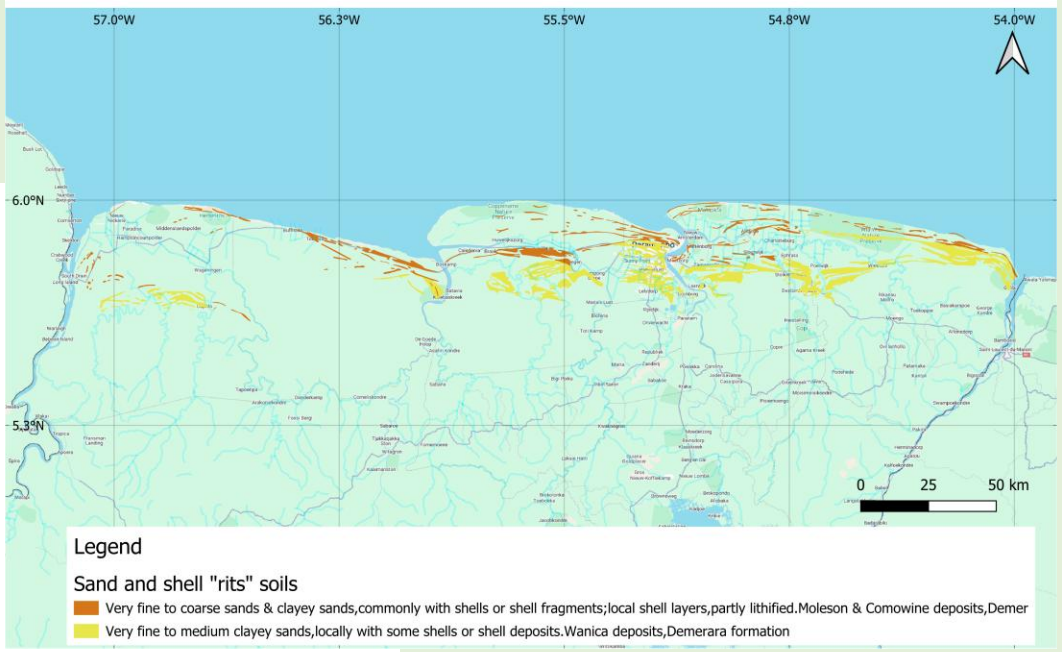
7. Onderzoek naar mogelijkheden van kleinschalige MAR nabij kreken en rivieren en binnenland (50 tot 3.000 m3/d)

Oeverinfiltratie in sand ritsen voor landbouw





Grondwater agenda in Suriname

1. Invoering van wetgeving op gebied van bodem- en grondwaterbescherming
2. Besparen grondwatergebruik (10 %) door terugdringen lekkages Non Revenue Water)
3. Ontwikkeling nieuwe pompstations ten zuiden van Paramaribo voor huishoudelijk grondwater (ca 100.000 m3/d)
4. Onderzoek naar mogelijkheden van ontzilting van grondwater voor Commewijne district (Solar/RO units van 300 tot 1500 m3/d)
5. Onderzoek naar mogelijkheden van winning van grondwater uit ritsen voor landbouw (PhD onderzoek Oclaya Verwey)
6. Onderzoek pompstation en/of grootschalige MAR bij Paranam (voor industriele ontwikkeling (24.000 m3/d)
7. Onderzoek naar mogelijkheden van kleinschalige MAR dmv oeverinfiltratie nabij kreken en rivieren en binnenland (50 tot 3.000 m3/d)

Oeverinfiltratie binnenland op terassen langs de rivieren

Oeverinfiltratie binnenland op terassen langs de rivieren

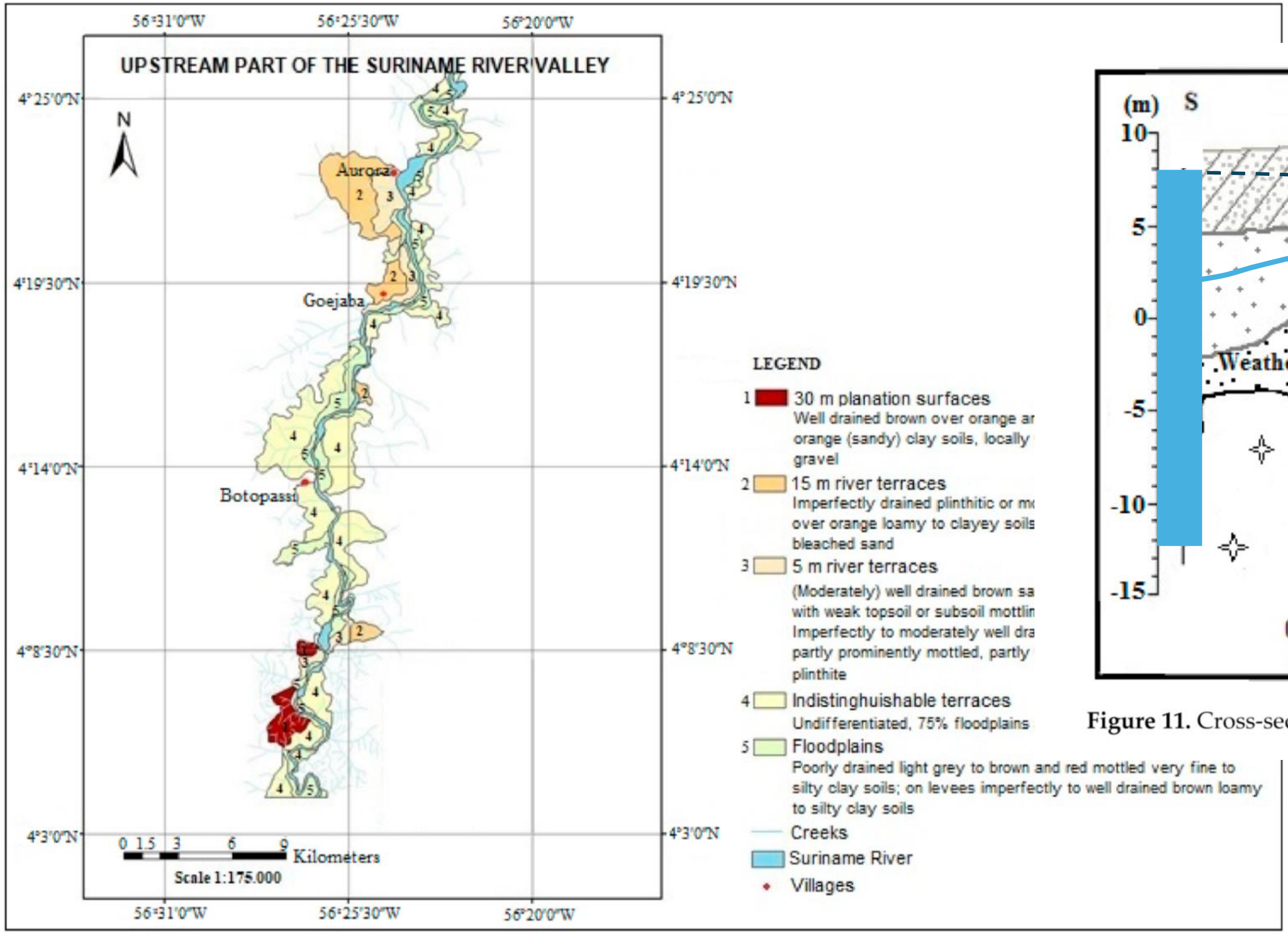


Figure 3. Map of terraces along the upstream river valley part of the Suriname River.

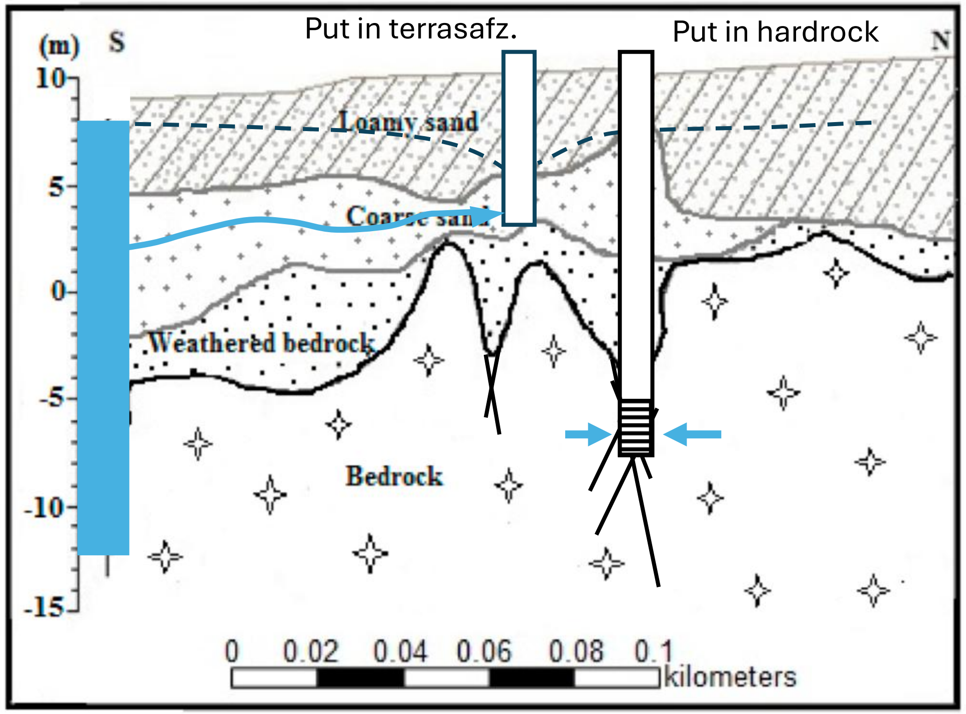


Figure 11. Cross-section through the island at the Brokopondo Sula (modified after Bleys [52]).

BEDANKT!