November 2015

IntoAction 5

Fog nets

Edited by Martina Mayerhofer
and Thomas Loster

Munich Re
Foundation
From Knowledge
to Action

Overview – Fog net projects

The Munich Re Foundation aims to facilitate a functioning water supply in arid regions. Fog nets produce drinking water. They improve quality of life and increase the resilience of people at risk.

Project launch
2007

Project management
Martina Mayerhofer und Thomas Loster

Visiting the project in the Anti-Atlas Mountains of Morocco: project manager Jamila Bargach (right) explains the design of the fog water collectors.

Contents

Water – Elixir of life and scant resource

People at risk and in poverty are at the centre of our work. We seek solutions in cooperation with aid organisations and local populations. Our goal is to improve the living conditions of the people affected by these problems. One of our main focuses is water as a resource and risk factor.

Water for the human race cannot be replaced by anything else. It is the foundation of all forms of life and civilisation. Our "Blue Planet" derives its name from the water covering some two thirds of its surface. Water is nevertheless a resource that is in short supply. A mere one per cent of the world's water resources are available as drinking water. Since its establishment, Munich Re Foundation has been supporting projects for the supply of water in arid regions. Fog nets provide a source of drinking water in these regions.

Hundreds of thousands of people across the globe could benefit from them in regions where fog forms naturally. Until now, fog collectors have primarily been erected in Africa and South America.

Together with our project partners in Germany and on location, we have been helping to install fog nets in arid regions since 2007 and thus improve drinking water supplies for the people living there. We have been able to gain a lot of valuable experience, but not always without complications. Our goal is to continuously improve and develop fog net technology even further.

Martina Mayerhofer

The idea of harvesting water from the air in arid but fog-intensive regions of the earth is as simple as it is ingenious.

Each year, 2.5 million people die as a result of water shortage or polluted drinking water. The United Nations estimates that by 2025, two thirds of the global population will suffer from a lack of water. Food production, energy and sanitation requirements are leading to an ever increasing demand for water. Climate change and population growth are exacerbating these problems.

Thirsty planet

Dense fog rises over Sidi Ifni on the coast of Morocco and drifts across the foothills of the Atlas Mountains. Fog nets can extract particularly large quantities of drinking water in this region.

Scarcity of life-giving elixir

The provision of all human beings with access to clean drinking water and sufficient non-potable water for other uses remains one of the greatest challenges of our times despite all efforts – particularly in arid rural areas. Many groundwater reserves are already suffering from excessive utilisation. In Africa, people spend about 40 billion hours each year just fetching water. It is mainly women and children who suffer the consequences because they often are burdened with the arduous task of walking for hours to reach the waterholes. The search for new methods of producing drinking water is more important than ever.

Floating springs – Harvesting drinking water from fog nets

From time immemorial, Kalahari bushmen in southern Africa have been using the dew which forms on plants and cobwebs in the cooler night temperatures. The scant dewdrops are a most welcome and even life-saving refreshment in the dry season. Experts have refined this method: today it is possible to “harvest” fog water. For this fog nets are used.

Underlying principle

The method is actually simple, but has not often been used to date. In many arid regions of the world where there is little rainfall and other water sources

do not exist, it has enormous potential. The prerequisite is enduring and natural fog formation: warm air rising into the atmosphere absorbs moisture that forms above large lakes and oceans, and then condenses in nearby mountainous areas. This creates a very waterlogged fog that unfortunately often does not lead to rainfall.

Fog nets capture these drops of fog. The wind forces the humid air through the vertical collectors. Minute water drops are caught in the net fabric and join together to form large drops. The drops run down the net into the collecting troughs. The fog water is collected in water tanks or fed into large water reservoirs.

The water gathered generally meets international drinking water standards. It can be used without further treatment for humans and animals and also for plant irrigation. Depending on the region and time of year, the daily water yields range between five and fourteen litres per square metre of net surface area – sometimes more.

Over twenty years ago, the Canadian organisation FogQuest designed the "Large Fog Collector" (LFC) with a net surface area of 40 square metres. It can collect up to 500 litres of water on one single fog day, and the concept is still being used at numerous fog net locations today.
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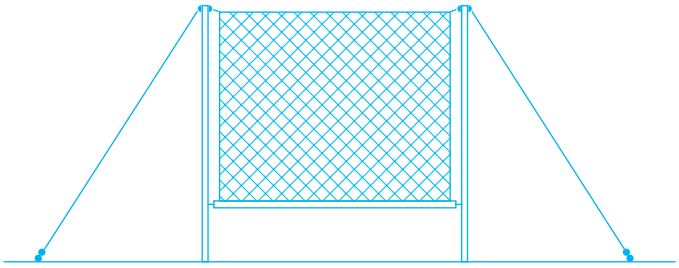
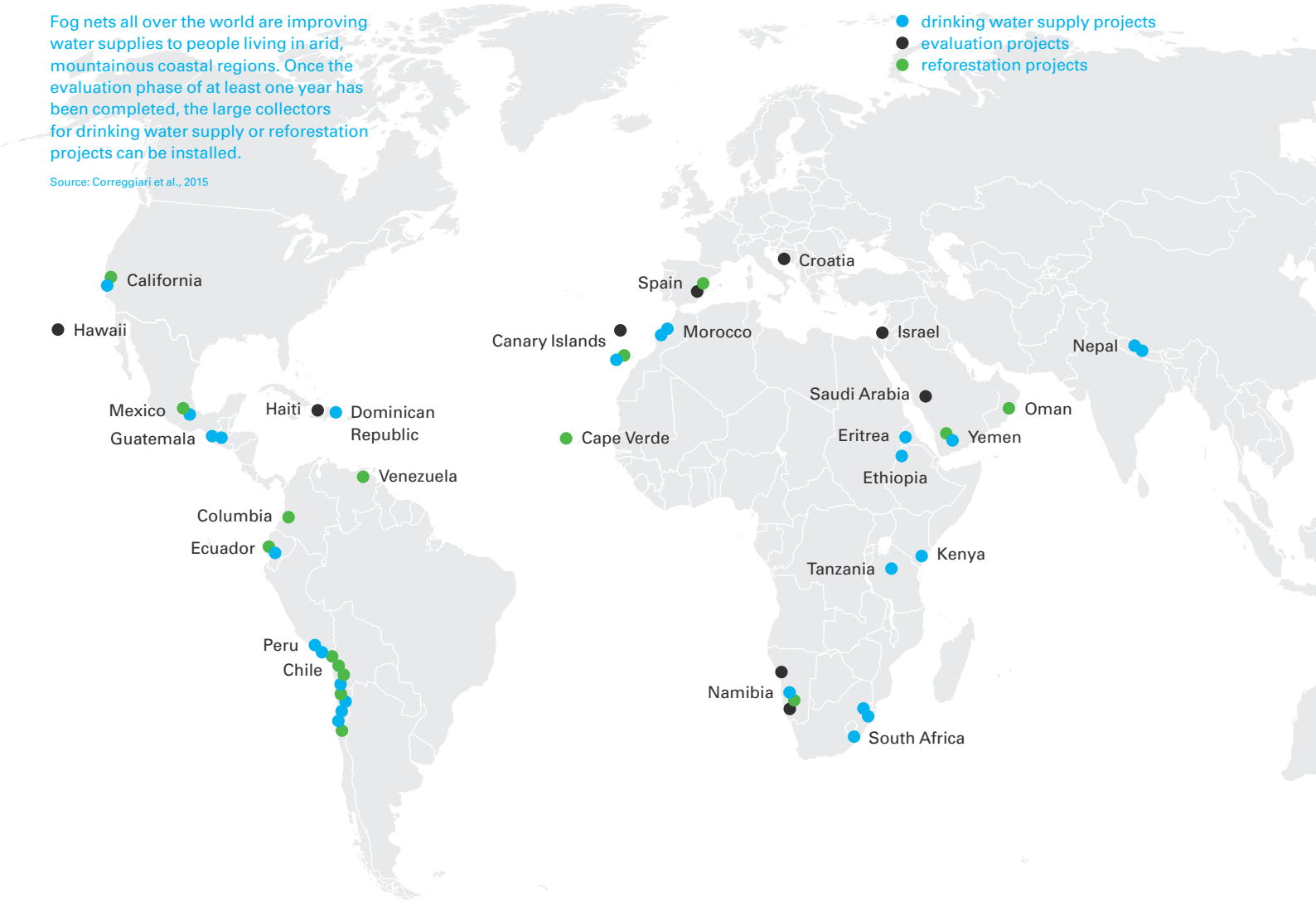


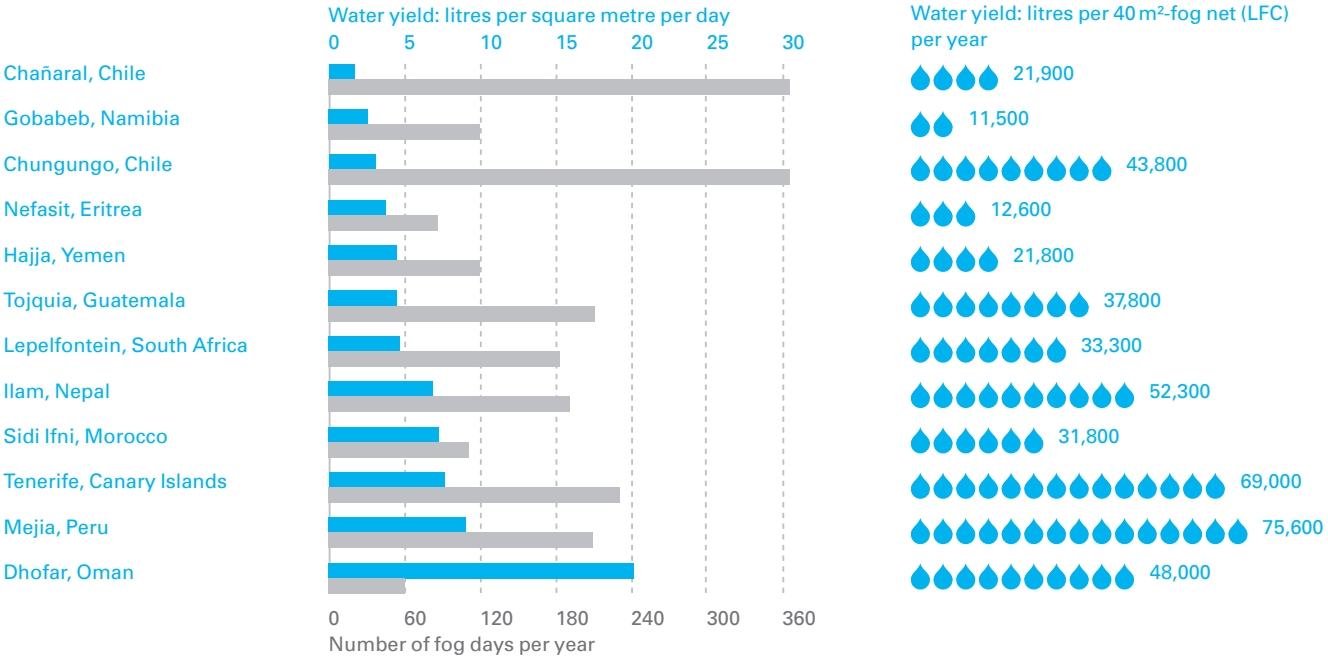
Just as dewdrops are caught in spiders' webs in the mornings, water droplets from moist air gather in the fog nets.

Worldwide fog net regions

Fog nets all over the world are improving water supplies to people living in arid, mountainous coastal regions. Once the evaluation phase of at least one year has been completed, the large collectors for drinking water supply or reforestation projects can be installed.

Source: Correggiari et al., 2015





Source: Correggiari et al., 2015

Technological limitations

Global experience gathered over a period of many years has shown that this technology does not work equally well in all locations. During squally, often stormy winds with speeds of over 120 km/h and strong solar radiation in the mountainous regions, the frames and materials quickly reach their limits:

- The nets bulge strongly in the wind. The collected fog water no longer flows into the collecting troughs.
- Many nets rupture along the seams and at the corners and are not seldom torn to shreds by storms.
- Collecting troughs made of rigid material (tin, hard plastic) become deformed or break in stormy weather.
- Often the nets chafe along the plastic-covered steel cables, used as cross-bracing for stability, and rip apart.

Enduring use of the nets in windy regions is only possible with extremely intensive maintenance work. Since 2013, the industrial designer Peter Trautwein from Munich has been working together with the WaterFoundation Ebenhausen to optimise the structural designs and materials used. The results are promising and show how fog collectors can be used as a reliable source for clean drinking water long-term. •

The fog nets are put to task by the strong winds that sweep across the highlands. They rip along the seams and are frequently torn to shreds by storms.

From knowledge to action
Interview with Aissa Derhem

Aissa Derhem, President of Moroccan NGO Dar Si-Hmad, has been pursuing the idea of supplying the population of the fog-rich Anti-Atlas mountains with fog water for over ten years. He achieved his goal in March 2015, when his fog net project was inaugurated, and is now making new plans.

Aissa, the 2015 World Water Day was an important milestone for you. Since that day, fog water has been flowing into households in the valley of Mount Boutmezguida. What does this mean to you?

I am proud: not for me or Dar Si-Hmad, but for the people in this valley. Don't forget that we worked on this for ten years. In the beginning, people didn't believe that we would provide them with fog water. Some even thought we were liars. But now they are happy and proud. Politicians, scientists, engineers and many people from the region came to the inauguration. This is a sign of appreciation and demonstrates the importance of the project.

Do you now have enough fog water for all the people?

Our fog water covers 50 % of the valley's water needs. But we want to install a new generation of nets developed by Peter Trautwein of the WaterFoundation in Germany. As you know, we are testing these "German nets" in our project area. They will provide us with much more drinking water since the yield is much higher.

What are the next steps for the project?

Firstly, we have to consolidate the project: we cannot replicate it if it is not perfect. Then we will take the next steps. There are even options to increase productivity. We will use renewable energy – solar and wind power – to increase the water yield. We will try to cool the nets. This will increase levels of water condensation and give us more water.

And finally, Aissa, after ten years of hard work, what do you think are the main ingredients for your success?

I am a thinker: an ideas person. I was convinced that we could do it. But I am less qualified for practical work. Luckily my wife Jamila is – she is the project manager on the ground. She is constantly pushing and working hard until she achieves a tangible result. We are a team that embodies your foundation's slogan "from knowledge to action". When you want to improve people's quality of life, you need both.

Fog nets have been supplying several hundred people with drinking water in the barren mountain regions of the Anti-Atlas range since March 2015. Women enjoy the greatest benefits as they are spared the four-hour walk to go to the well every day.

Ten years from vision to reality

Right on time for World Water Day on 22 March 2015, our fog net project on Mount Boutmezguida in Morocco was officially opened with an inaugural ceremony. Now fog water flows from the top of the 1,225-metre mountain into the valley, supplying four villages and a school. Our Moroccan partner organisation has installed 600 square metres of fog nets. "It was a long road," explained Aissa Derhem, President of the Dar Si-Hmad NGO, during the opening ceremony of the project near Sidi Ifni, "but we have now reached our goal. The tanks are full and we can supply the people with drinking water."

The fruits of hard labour

Roughly eight kilometres of pipelines were laid during years of work in the stone-hard mountain slopes, filter systems procured, water tanks renewed and built and, in the final step, the supply lines connected to the households. Before this, villagers had to get by on roughly just eight litres of water a day. Now they are all adequately supplied. Above all it is the women and girls, who formerly had to fetch the drinking water from a remote well, who are benefiting most. Their quality of life has been greatly improved.

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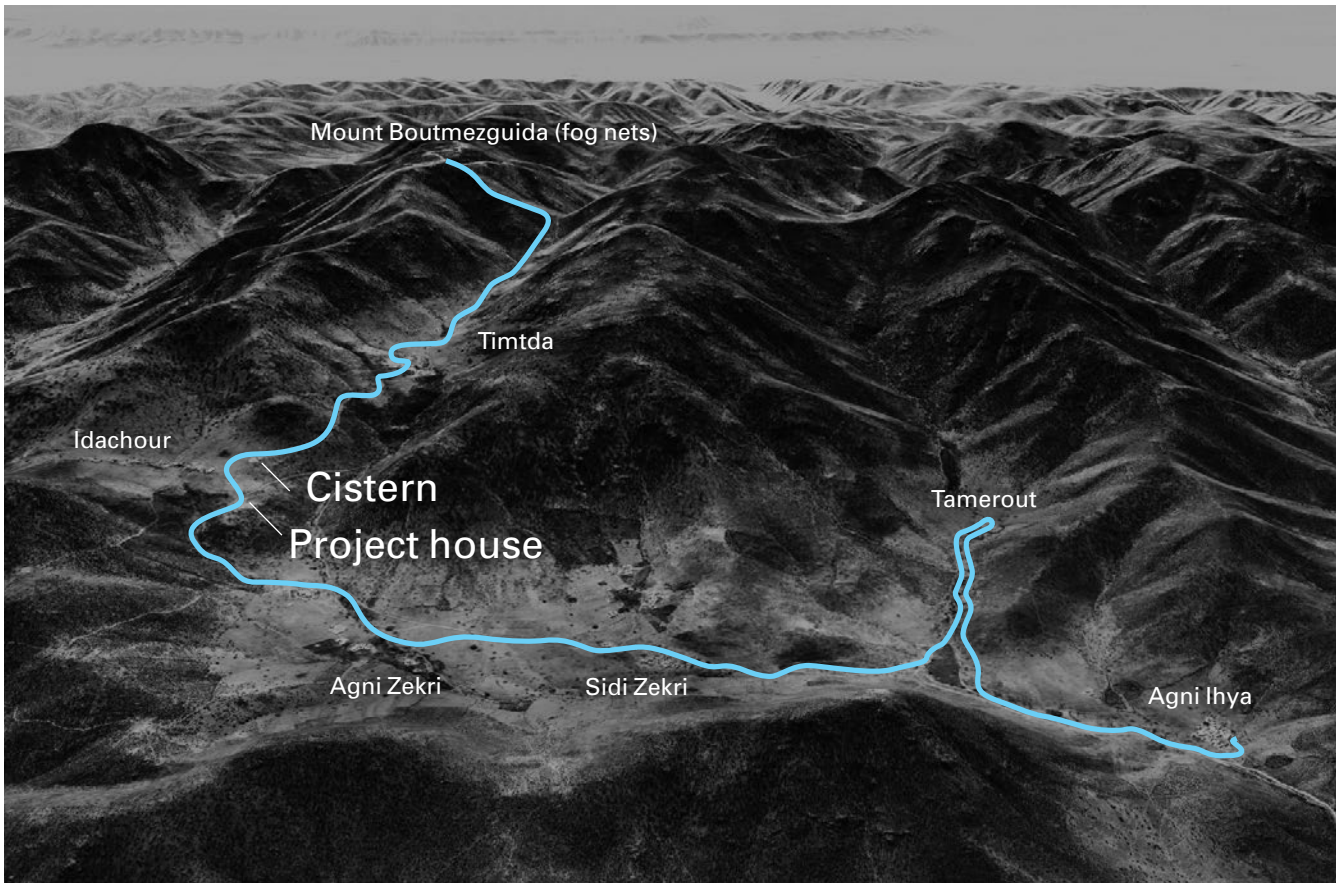


A schematic depiction of our fog net project in the Anti-Atlas Mountain Range in Morocco. The blue line marks the water pipeline leading from the fog nets to the cisterns.

Source: Munich Re Foundation, own blueprint 11/2015, basis of map: Google earth

The fog water is not free of charge. Each household connected to the supply must pay a monthly water rate of around two euros and approximately €0.40 per 1,000 litres of water. "If the water has no value, it will be wasted," emphasises Aissa Derhem. "Our fog water costs even less than the water from the wells. It is important to commercialise the project otherwise it cannot be sustained in the long term." Maintaining the system costs money. A prepaid system, with which the villagers pay a small fee for the water, regulates payment. "In the medium term, if everything goes well, we want to hand the project over to the people in the communities," says Derhem.

The fog nets deliver several thousand litres of drinking water daily during the fog season from December to June. Enough to supply more than 400 people. The nets meet approximately half the region's requirements. Tanks installed on the mountainside ensure that the water remains available well into the dry period.

"There have been repeated setbacks," Jamila Bargach, the project manager, tells us." Nets were ripped; wind strengths of up to 100km/h can occur on the mountain. The roads were often blocked or closed. The breakthrough for me was the moment USAID and the Munich Re Foundation promised us financial support. We then knew that we were being recognised and that gave us the energy we needed." From the beginning, Victoria Marzol, geographer at the Universidad de La Laguna, Tenerife, was a consultant on the team. She has been doing research in the area of fog net technology for many years.

Africa's first fog observatory

The project has further successes to show: the first fog observatory in Africa has been built directly below the summit of Boutmezguida. Dar Si-Hmad can rightly be proud of this achievement. All the technical equipment of the fog net system is housed in a small building where it is technically monitored, important data collected, the water flow measured and the filter system operated. Fitted with a modern solar collector, the small observation station works completely independently of the main power grid.

Below: Dar Si-Hmad workers installing the fog nets on Mount Boutmezguida in the Anti-Atlas Mountains. The nets supply four villages and a school in the valley with drinking water.

Right: Women learn the responsible use of water in training programmes specifically designed for their needs. Household hygiene issues are also discussed.

Workshops for the people

The technical aspects of water production are one part of the task. Training the local people in handling this limited, precious resource is another. Dar Si-Hmad has designed a training programme for children and adults specifically for this purpose. In the WASH workshops (Water, Sanitation and Health), trainers teach specific target groups how to treat water responsibly. They also teach the basic principles of hygiene such as regular hand washing. As the houses in the mountain region do not yet have sanitary facilities, the problem of wastewater disposal must also be addressed. Dar Si-Hmad has commissioned two technical studies to examine which solutions are the most suitable.

Fog nets of a new generation

Since the spring of 2012, Peter Trautwein, an engineer at WaterFoundation Ebenhausen, has been testing new net materials and sturdier structure designs directly on site. With funding from Munich Re Foundation, he has developed the "CloudFisher" – a new-generation fog collector that is wind resistant and delivers significantly higher yields.

"When we have consolidated the project and equipped it completely with "German nets", as we call them, we can multiply the technology in Morocco and other countries," explains Aissa Derhem. "Then we can prove that simple and innovative technology is capable of improving the living conditions of countless people in fog regions." A wonderful goal whose achievement has come within reach.

Chronology
Fog net project in the Anti-Atlas Mountains of Morocco

June 2006
Installation of test collectors (Small Fog Collector, SFC, net size: 1 m²) in two locations in the Sidi Ifni province

2006–2010
Evaluation phase: regular water measurement and analysis, average water yield on the summit of Mount Boutmezguida: 10.5 l/m² per day

June 2011
The Moroccan organisation Dar Si Hmad wins Munich Re Foundation's call to tender for 2011/2012 Fog Net Project funding. Fog nets are to provide three villages and a school with water

First half of 2013
Completion of pipeline installation in two villages, workshops for village residents, scientific research on social aspects and wastewater systems, acquisition of further funding resources (among others from USAID)

Second half of 2013
Confirmation of Moroccan State funding for the construction of pipelines to the private houses in the villages, construction of a second tank (250 m³)

First half of 2014
Construction of a fog observatory on the summit of Boutmezguida for technical monitoring and data analysis, development of a communication system for the fog net facility

Second half of 2014
Installation of water filter systems and test phase of the prepaid system for water supply, health and hygiene training courses

2009
Detailed water requirements analysis in the surrounding villages

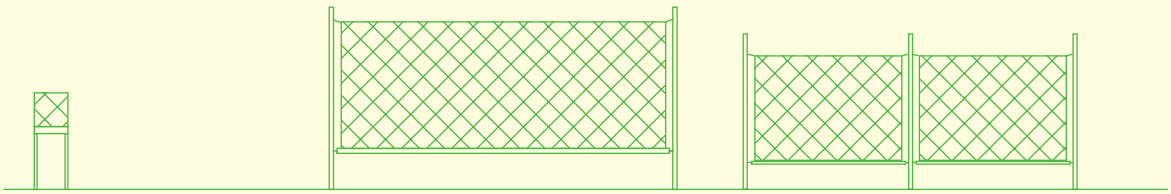
2011
Analysis of the results and site selection, participation in project bidding process, planned net surface area: 600 m²

From July 2011
Starting signal for installation of the collectors (net size: 40 m²) on Boutmezguida, reduction of net surface area to 15 m² (installed as double collector of 30 m²) due to severe wind forces, total net surface area of 295 m² installed

Autumn of 2011
Clarification of further project modules: water management and distribution, payment systems

First half of 2012
Pipelines from summit to water storage tanks installed (7.7 km), cleaning and restoration of an existing tank (224 m³) for fog water storage, installation of further fog collectors

Second half of 2012
Completion of net installation (600 m² in total), continuation of pipeline installation: Connection to villages



Small Fog Collector, SFC: net size: 1 m²

Large Fog Collector, LFC: net size: 40 m²

Collector in Morocco: net size: 2 x 15 m²

21 March 2015
Inaugural ceremony celebrating the opening of the facility

Jamila Bargach, project manager and director of Dar Si-Hmad

Overview
Fog net project Morocco

Project management
The Moroccan NGO Dar Si-Hmad uses sustainable initiatives to promote the preservation of the traditional cultural area in the southwest of Morocco. The two founding members Jamila Bargach and Aissa Derhem have been committed to the amelioration of the supply of drinking water in remote villages of the Ait Baamrane region for over 10 years now. The fog collection project at Boutmezguida lies at the heart of their work.

Clearly defined tasks for Science
Interview with Victoria Marzol

Victoria, since when have you been researching fog net technology and why?

In 1994 I was in Chile and visited a large fog net project there. It had 74 nets, that fascinated me. The net facility was practically in the desert and supplied the people in La Serena and the fishing communities on the coast with drinking water. Unfortunately, El Niño later destroyed the nets. I spoke about this at my university in Tenerife and we started our own project on the island.

What was the project about?

In contrast to the facility in Morocco, we did not focus entirely on drinking water but addressed many different aspects. The water was used for animals such as goats and bees and also for plants and reforestation. In addition to this, we also used it for fire-fighting purposes and supplied reservoirs with fire-extinguishing water.

That demonstrates the diversity of possible applications?

Yes, absolutely. Drinking water is not the only issue at hand.

What do you think of the project on Mount Boutmezguida?

It's wonderful and I am proud to have been involved since the very beginning. To my mind, several components have been decisive for its success: the clear vision that something like this can work, and the stamina that Dar Si-Hmad demonstrated. In Morocco, numerous stakeholders from the widest spectrum of countries have worked together, and this diversity – paired with the openness and strong will of Dar Si-Hmad's project manager – ultimately led to success.

This does not work as well in all projects, does it?

No, you need a mixture, like in Morocco, if you want to be successful. You don't meet with a comparable situation very often.

You have heard about the latest fog net technology. Will the new nets developed by Peter Trautwein from the WaterFoundation revolutionise fog net technology?

I think so, yes, because the new nets have two advantages: they have a higher yield and are much more stable, which is an enormous advantage in windy areas for example. In Tenerife we are currently comparing the conventional "Schemenauer technology" yields with those of the new nets in Morocco by means of scientific measurements. I'm expecting the Trautwein nets to perform much better. But, in the final analysis, it's also the price that counts. The technology must not be too expensive.

What do you consider to be the role of science in fog net technology?

Science must not just act for the purpose of research alone. There are three clearly defined tasks: it must examine fog physics, such as the size of the water drops and quantities. They vary greatly depending on the elevations. Then, logically, it must also deal with water chemistry. Aspects such as mineralisation but also subjects such as contamination and wastewater are important. And last but not least, it must also address the actual use of the water. As I mentioned, there are many different possibilities of using it. Water can serve humans as drinking water, but it is also important for plants, animals and the environment. This all must be investigated more closely. Fog net technology can therefore be a blessing for many regions of the earth.

Victoria Marzol, geographer at the Universidad de La Laguna, Tenerife, has been doing research on fog net technology for many years. She has been providing scientific support for the Moroccan project since it first began.

Since November 2013, a large-scale test system consisting of six fog collectors has been in operation on the top of Mount Boutmezguida in Morocco. Its goal: to obtain drinking water from fog and dew with even greater efficiency than before.

Fog net technology 2.0

What happens if large fog collectors are unable to withstand the strong winds in the mountains? Or if the supporting structures buckle and the nets tear or bulge so strongly in the wind that the water harvested can no longer flow into the collecting troughs? The fog collectors that were originally developed and set up in a number of countries by the Canadian organisation FogQuest have rendered valuable service in recent decades. However, in regions where wind speeds can attain up to 120 km/h and more, the 40 square metre nets ultimately proved too large and occasionally unstable.

"CloudFisher": what's new?

Since spring 2012, Peter Trautwein, an industrial designer from Munich, has been working on a new fog collector in collaboration with the WaterFoundation Ebenhausen. To take the wind out of its sails, Peter Trautwein reduced the surface area of the net from the original 40 square metres to just nine square metres. Six of these small nets were stretched side by side across metal frames, each of them attached with rubber expanders. The nets are made of six different materials and structures. They range from simple Raschel nets, the standard material for fog nets for many years, to three-dimensional high-tech textiles.

A sturdy plastic grid mounted on the leeward side of the net supports the delicate fabrics. The dynamic net-holding system is also new. The new structure fitted with rubber expanders is no longer rigid and inflexible but now pliant and at the same time abrasion- and weather-resistant. The drip trays made of food-grade poly-ethylene are also elastic and can move in the wind. All materials used are characterised by UV-resistance, as not only the force of the wind but also the solar radiation is not to be underestimated.

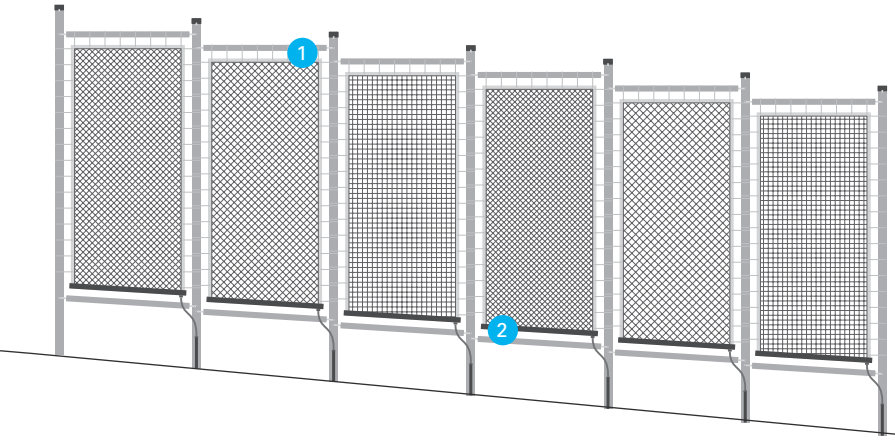
Munich industrial designer Peter Trautwein designed the new "CloudFisher". It can generate a great deal more drinking water and is more stable in strong winds than the nets used so far around the world. Six different types of nets were tested at the same time for stability and yield in the Moroccan highlands. The test phase was concluded in July 2015.

Source: Munich Re Foundation, own blueprint (11/2015), database: WaterFoundation Ebenhausen

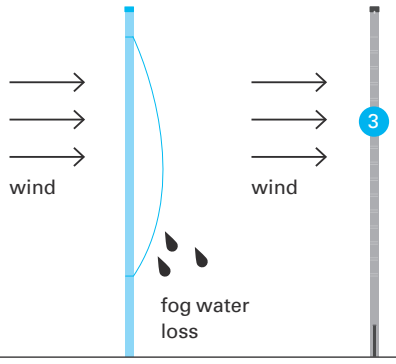
1 Dynamic netholding

2 Flexible drip tray

3 Support function through sturdy plastic grid

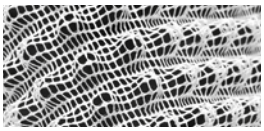


side view: net without supporting grid

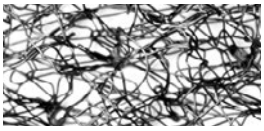


side view: net with supporting grid

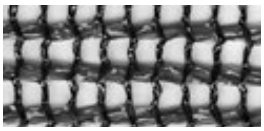
Raschel net (PP), double-layered



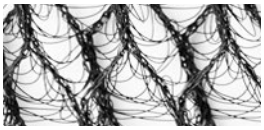
Dimple dot fabric F-20200/14 (PES)



Enkamat 7220 (PA6)



Shade net (HDPE)



Spacer fabric (PES)

Hail protection net (HDPE), double-layered

Promising results

In July 2014, the results of the first water yield evaluations were made available. They show clearly that the three different types of fog net made of spacer, hail net and Enkamat fabric consistently delivered the highest water yields. These are approximately one third higher than the yields from the Raschel nets previously used. This is an impressive and gratifying result, as each additional litre of water translates into more quality of life for humans and animals. The quality of the fog water was also analysed in detail. It is a great deal cleaner than the water from the well which had previously been the only source of drinking water.

In 2015, the test system was further optimised. Structural details were improved, rubber expanders and net textiles replaced, collecting troughs enlarged. The test phase was brought to a close in July 2015. The “CloudFisher” is now ready for its first call of duty under real operating conditions.

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Left: Attached by rubber expanders, the different kinds of net fabrics are stretched between the masts of the collectors. An additional plastic grid behind the fabric supports the net in the wind.

Right: Six different kinds of nets were tested in the “CloudFisher”. The spacer, hail net and Enkamat fabrics consistently delivered the highest water yields.

The newly designed test collector was installed on Mount Boutmezguida directly beside the fog nets of the previous generation. Up until the end of the test phase in July 2015, no damage of any kind had occurred.

Research support

Prof. Annette Menzel, head of the Department for Ecoclimatology at the Technical University Munich, and her team conducted the scientific research for the fog net project. During the fog season from December 2013 to June 2014, the water yield, wind speed and direction, the temperature and relative humidity on top of Mount Boutmezguida were measured on a daily basis. The Technical University Munich purchased the requisite measuring equipment with the financial support of Munich Re Foundation. Members of Technical University staff worked together with the WaterFoundation team and local helpers to install tipping counters, wind gauges and the requisite data loggers. The loggers automatically transfer the data readings to Munich so that technical failures are quickly noticed.

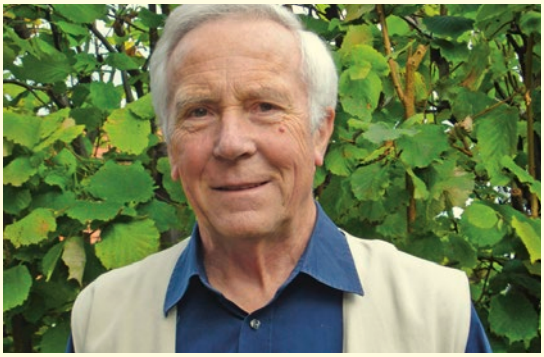
However, things did not always proceed smoothly: sand in the fog water led to tipping counter failures, problems occurred while reading out the data. After the initial difficulties had been surmounted and six months of data collection and analysis completed, the team was justifiably proud of the results of its research work. Within the framework of the project, two bachelor theses and one student research paper have been successfully completed so far and have provided important insights into net types, yields and suspension methods.

First major test under real operating conditions is planned

Some important financing issues have not yet been finally resolved. But if everything goes according to plan, perhaps even in the spring of 2016, the newly designed “CloudFisher” will be installed for the first time in a large-scale net facility. Our Moroccan partner organisation Dar Si-Hmad has decided to replace all the old fog nets on Mount Boutmezguida with second-generation collectors.

The WaterFoundation Ebenhausen and Munich Re Foundation are supporting the project. The goal of all the project partners is to make the new net technology internationally known and multipliable as quickly as possible. •

Fog water tastes very refreshing
Interview with Herbert Hruschka



Process engineer and environmental expert Herbert Hruschka has been supporting WaterFoundation Ebenhausen for many years in all matters relating to water quality. In June 2014, he sampled water from the "CloudFisher" in Morocco for the first time. The Bavarian State Office for the Environment in Augsburg and the Water Authority of Landshut analysed the samples. The results are very promising.

Mr. Hruschka, for non-experts it's difficult to imagine that you can drink water obtained from fog without chemical treatment. Is the water really so clean?

Fog water is very clean. The water harvested by the project in Morocco is condensed water vapour from the Atlantic. Impurities that affect the quality of the water can, however, be caused by the atmosphere or soiled nets. Luckily, there are no companies that pollute the air in the area of "CloudFisher". The water can be consumed without treatment.

The water analysis results for the "CloudFisher" were made available in July 2014. Is the fog water comparable with for example German drinking water?

Drinking water in Germany also varies in quality. This depends on the ground from which the water is pumped, or on the water tank from which it is supplied. In the German Drinking Water Ordinance, the legislator has specified threshold values for certain parameters that must not be exceeded. The fog water from the "CloudFisher" meets all these limits. It also contains low concentrations of salts, minerals and trace elements. It is therefore highly suitable in both physical and chemical terms for use as drinking water.

In Morocco it is planned to mix the fog water with groundwater. Is this possible?

Depending on the chemical composition, mixing water from different sources can cause problems. For example, if iron-rich groundwater is brought into contact with oxygenated fog water, the iron oxidises and precipitates in the form of flakes. The water then turns red and forms a rusty layer on the inner sides of the cisterns and pipes which constricts the open cross-section. This can block up the pipes.

Are there other special aspects?

When mixing the water, the most important parameter is the pH value. It indicates whether the water is acidic or alkaline and largely determines the solubility of substances contained in the water. Problems during mixing may result from the fact that the pH value changes logarithmically, while changes in the substance concentrations are linear in progression. This can affect the quality of drinking water or damage the piping system. As soon as the results of groundwater analysis are available, we will see whether further action is needed.

The fog water is stored in cisterns. Does the water not become mouldy?

The cisterns are buried in the ground and are protected from sunlight and external influences. In addition to this, long storage periods are not necessary due to the size of the tanks. The water consequently remains fresh.

You will probably already have tried the water. How does fog water taste?

Of course I tried the fog water immediately. It is colourless and odourless and tastes very refreshing.

Women in Morocco — More rights through fog water
Interview with Leslie Dodson

Leslie, during the inauguration of the fog nets in Morocco on 21 March 2015, you were honoured with a special certificate for your work.

Yes, during my doctorate at the Atlas Institute of the University of Colorado, Boulder, I examined the living conditions of women in Morocco. I developed a communication method which opens up new opportunities for women with the help of mobile phones.

What is it about exactly?

I'm working towards new paths in development cooperation and support the Mobiles for Development (M4D) approach. After nine months of research and intensive talks with the women, I developed a new information system for the communities. The village women now communicate with each other via text messages without a problem and were able to become water manageresses as a result. They're experts when it comes to questions of water.

But why do they need a mobile phone for communication in the first place, why don't they just talk to each other directly or with the men?

In the Berber culture there are strong restrictions. Women cannot just go to the men and tell them what to do verbally. To protect their own reputation and the honour of the family, personal conversations between women and men, in other words, face to face, are considered improper and even forbidden. This also applies to sending text messages. But what happens if there are supply problems or the pipelines are damaged?

Then the women cannot even warn the male engineers or water managers?

That's right. For us in the US or Europe such a thing is utterly unimaginable. Thanks to our idea, however, the women can now communicate indirectly through a kind of communication centre that we have set up together with Dar Si-Hmad. We have established a communication triangle.

How does that reinforce the role of the women?

As time goes on, the women are taking on an active role in water management. They are learning to use the mobile phone with self-confidence, which is still unusual out here in the country. Their responsibility is gradually increasing and the men are also beginning to accept this more and more.

Is that enough?

Communication is just one element. We have taught the women how to use hammers, screwdrivers and spanners. It was great seeing how their confidence in working with the tools slowly increased. A real jolt went through the groups, you could see it on their faces. Now they go to work on the pipelines and taps like plumbers, not long ago this was unimaginable.

A great success for you, I imagine?

Yes, as foreigners we cannot be too demanding, the change is taking place slowly and quietly. However, I have been able to observe that the role and knowledge of the women is being increasingly accepted and valued by the men. My Ph.D. thesis proves that the new self-awareness leads to more respect, rights and a stronger partnership over time.

Leslie Dodson, social scientist at Colorado University, Boulder, USA, does research on women's rights and development. In her Ph.D. thesis she examined how fog net technology in Morocco has strengthened the status of the women in the region.

Two village residents proudly present the new water tap in their home during the opening ceremony of the fog net project on 21 March 2015.

The area roughly 200 kilometres to the southwest of Mount Kilimanjaro offers ideal conditions. The climatic and topographic conditions near the major Serengeti and Tarangire national parks are perfectly suited to the production of water from fog collectors.

Fog nets in Tanzania — Water from the clouds

The nets in the Daraja la Mungu community (Babati region) supply the rural population with drinking water. The whole region benefits as a result. At other fog net locations, the collectors supply drinking water for schools.

Every night, heavy fogs form above several salt lakes – some of them larger than Lake Constance – and, depending on their intensity, gradually dissipate during the early morning hours as the sun grows stronger. In addition to these salt lakes, a mountain ridge running along the African continental rift stirs up thermal winds that drive the fogs across the highlands. The German organisation p(e)d world has been installing fog nets in the Babati highlands since 2009 – with great success.

Bernhard Küppers and Christina Bösenberg, both founding members of the p(e)d world e.V. association, have been involved since 2008 in school projects in Tanzania where they became aware of the immense problems with the supply of water. Traditional well construction is not possible, as the settlements are located on a highland plateau at an elevation of over 2,000 metres. Children – most of them girls – must walk several hours each day to fetch water, usually of inferior quality. At times it is muddy, and it must always be boiled.

Project launch following promising tests

The project was launched in 2009 with the installation of small test collectors by p(e)d world in ten different locations. With a daily yield of ten litres of water per square metre, the result was very satisfactory. The installation of large fog nets could begin. Several large double collectors with a net surface area of 80 square metres each were thus set up at two schools in Qameyu and Umagi. They supply more than 600 pupils with drinking water. The peak values in Qameyu even often exceed 30 litres per square metre of fog-net surface area a day.

Of course, this cannot be accomplished without local support. Ochieng Anudo heads a small Tanzanian NGO. He takes care of the formalities with the authorities, keeps the population informed and coordinates the Tanzanian workers during net installation. Pupils and teachers are also always involved, since schools, in particular, have proven to be ideal locations: the teachers reliably record important measurement readings, carry out small repairs on the collectors and involve the pupils in system monitoring. The water is collected in tanks at the nets, from where it is drawn and carried to the school. Different children are assigned to water supply duties every week.

Strong demand in the region

News of the success at Qameyu and Umagi spread quickly. More and more schools in Babati asked to be included in the project. With the financial support of Munich Re Foundation, p(e)d world has been able to set up five more double collectors at three schools since the end of 2013. They supply more than 1,000 pupils with drinking water. A pupil needs two to five litres of drinking water a day on average.

»

Above: Farmer Safari lives besides the nets and takes care of cleaning and maintenance. As payment for his work he receives fresh drinking water.

Below: The population in the Babati region know how important the supply of water by the fog nets is. There are many requests for further fog net sites.

More than 400 pupils come to Qameju for school lessons. Girl pupils who formerly had to walk long distances to collect water now have more time for school.

A double collector allows approximately 100 children to be supplied with clean water. This also benefits the pupils in other ways: they have more time to learn, more time for themselves and thus better opportunities for personal development. Two more fog nets have been installed in the community of Daraja la Mungo. This community is home to a population far exceeding 1,000 people, some of whom live in the most basic of mud huts, distributed over an area of several square kilometres. In contrast to the schools, a Village Executive Officer and people appointed from within the community are responsible for taking care of the nets installed at this location.

Water tanks are important

The fog water produced is not always used immediately. Until now, large black plastic drums have served as collecting containers. However, they are wholly unsuitable for long-term water storage. The material is not food-safe and when the drums are exposed to solar radiation the water quickly becomes mouldy. For this reason, p(e)d world decided in the summer of 2013 to build two large tanks at the Qameyu and Umagi schools. With a holding capacity of 10,000 and 20,000 litres respectively, water storage is now taken care of. Now, even several fog-free days in a row are no longer a problem for the drinking water supply in the schools.

The Tanzanian fog net project has not yet been concluded. The p(e)d world organisation has many new ideas and plans. The demand remains substantial and, if everything works out, we will continue to support the installation of fog collections in Tanzania and the region. •

Overview
Fog net project Tanzania

Project management
The German NGO p(e)d world e.V. is committed to securing access to clean water and education to people all over the world through innovative fog nets. The two founding members Bernhard Küppers and Christina Bösenberg have been advocating the improvement of the supply of drinking water at school locations throughout Tanzania.

Chronology
Fog net poject in the Babati district of northwestern Tanzania

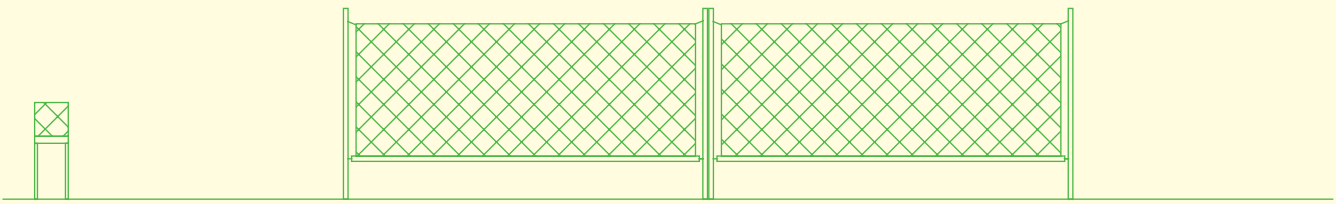
2009
Installation of ten test collectors (Small Fog Collector, SFC, net size: 1 m²) at different school sites in the Babati district

2010
Evaluation of the results and site selection, acquisition of sponsors, installation of the first two double collectors (Double Large Fog Net Collector, DLFC, net size: 2 x 40 m²) at schools in Qameyu and Umagi

2011/2012
Number of sites gradually increased:
- two DLFCs in Qameyu (secondary school: 600 pupils)
- one DLFC in Umagi (secondary school: 400 pupils),
- two DLFCs in Endoji Village (approximately 2,500 residents),
- one DLFC in Endow (primary school: 350 pupils)

2013/2014
Installation of seven more DLFCs in the following locations:
- two DLFCs in Gidngata (secondary school: 500 pupils),
- two DLFCs in Endabok (primary school: 150 pupils),
- two DLFCs in Daraja la Mungu Village (approximately 2,000 residents),
- one DLFC in Endow (primary school: 350 pupils)

September 2015
Construction of two large water storage tanks (with a holding capacity of 10,000 and 20,000 l respectively) at the Qameyu and Umagi sites with funding from Munich Re Foundation among others



Small Fog Collector, SFC: net size: 1 m²

Double Large Fognet Collector, DLFC: net size: 2 x 40 m²

2009–2010
Evaluation phase: regular water measurement and analysis, best result on the high plains of Qameyu, average water yield: 10 l/m² daily

October 2013
p(e)d world e.V. wins Munich Re Foundation's call to tender for 2013/2014 Fog Net Project funding. Ten new DLFCs are to be installed in the Babati district

Project still under way: the demand for drinking water is immense. The installation of further test collectors in other regions is planned

Fog nets can be installed in any arid region of the world in which fog forms naturally and continuously. The check list below provides an overview of important project aspects and of the requisite steps involved.

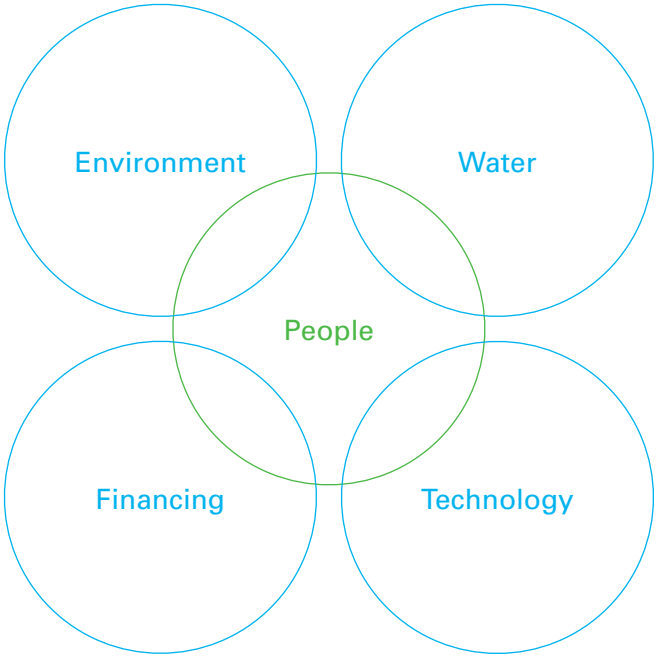
Harvesting drinking water from fog — Check list for project start

Environment

- Legal environment (regulation, mandates etc.)
- Location search: possible land purchase
- Installation approval, pipeline and tank installation by state authorities
- Communication and coordination with municipal and national authorities, government acceptance
- Community structures (responsible bodies, ownership etc.)

Water

- Availability (well locations, tanks, quality etc.)
- Water quantities required, quality (mineralisation etc.)
- Water prices (conventional versus new technology)
- Necessity of sewage system



Financing

- Determination of capital requirements for the duration of the project (planning, implementation, maintenance, evaluation) for all aspects such as technology, human resources, tenancies etc.
- Equity capital, search for donors, sponsors etc.
- Possible introduction of a water payment system for long-term cost recovery
- State acquisition possible (legal foundation and financing)

People

- Number of people to be supplied
- Urgency of water supply (status quo), hygiene aspects
- Purpose of water: drinking water, livestock, agriculture or forestry
- Existing knowledge, capacity, training, contacts
- Social structure, fair water distribution
- Responsibilities for management, maintenance etc.

Technology

- Collector requirements in respect to wind, UV radiation, accessibility (mountainous terrain versus flatlands)
- Number of collectors required (large, small etc.)
- Quality adaptation of materials required
- Measuring equipment for water quality assessment etc.
- Material sourcing for collectors: regional or imported?
- Water storage, pipeline routing and filter systems
- Maintenance aspects (caretakers, costs etc.)

Concept: Munich Re Foundation,
T. Loster, C. Barthelt

Project implementation
In ten milestones to success

1

Subsequent to a detailed water requirement analysis: installation of small test collectors (SFC: Small Fog Collectors) in different locations in the region. Fog nets of only one square metre in size can be obtained from the Canadian organisation FogQuest.

2

Performance of regular water measurements at the SFCs by reliable people; maintenance and regular inspection of the test collectors; data logging and analysis over a longer period of time (minimum: one year). Subject to positive test results (= more than five litres of water per square metre of fog area): beginning of actual project planning.

3

Site selection: search for the best location for the collectors. Where can the largest number of people be supplied within the shortest distance possible?

4

Preparation of a cost estimate with budget planning and financing plan, preparation of a project schedule, funding applications.

5

Submission of applications to the regional authorities for state approval of net installation.

6

Procurement of the requisite materials from domestic and international sources; processing of imports for customs clearance etc.

7

Recruitment of local helpers and staff to assist with the installation of the nets, the construction of the pipelines, the water collectors and possibly the filter systems.

8

Installation of complete system.

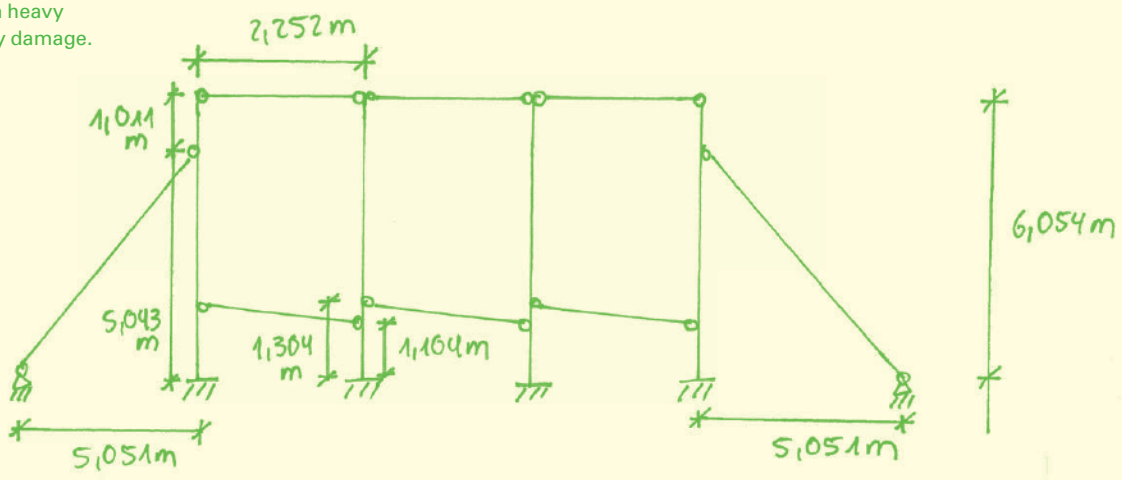
9

Training courses for water and project managers (net maintenance, servicing) and for the residents (water conservation, hygiene, sewage issues etc.).

10

Project start-up and handing over of ownership to the local project managers. Regular servicing and maintenance of the project by the water managers on site.

Drawing of a fog collector: structural engineers calculate the requisite strength of the masts and braces so that even heavy winds cannot cause any damage.



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p(e)d world
Page 27 (middle)

Ochieng (left), project manager with p(e)d world in Tanzania, takes care of the maintenance of the nets and keeps in touch with the project leaders at the various sites.

Project partners

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Germany

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Department for Ecoclimatology,
Germany

Dar Si-Hmad,
Morocco

WaterFoundation Ebenhausen,
Germany

Fog rises in the Anti-Atlas Mountains of Morocco. The "CloudFisher" is ready to produce drinking water.

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