Foto source: König

Fig. 1
STAIRS FOR THE RAIN WATER FROM THE ROOF TO THE CISTERN, CAS CONCOS, MALLORCA

RAINWATER HARVESTING - A GLOBAL ISSUE MATURES

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The English term "Rainwater Harvesting" has been widely accepted internationally. Interestingly enough, the emphasis has not been on the utilisation of rainwater but on its harvesting. Harvesting has to do with "yield" and implies a "gift of nature". It goes without saying, however, that the harvest should also be utilised and every yield is preceded by its own activities.

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Mankind will have to deal more carefully in the future with the world-wide available and utilisable freshwater reserves. This is primarily a question of awareness and education. In Taiwan, Korea and Australia, programmes to promote rainwater utilisation have been launched in schools in order to familiarise future generations with this topic.

WATER DISTRIBUTION WORLD-WIDE:

(Source: Water in Crisis, World Water Council, Marseille 2002)

- 0.025% of the amounts of water available world-wide is utilisable
- 1.4 billion people have no access to clean drinking water
- 2.3 billion people lack adequate sanitation
- 7 million people die every year from water-borne diseases
- The daily domestic water consumption per capita is
  - 350 litres in North America
  - 200 litres on average in Europe
  - 130 litres in Germany
  - 20 - 30 Litres in Sub-Saharan Africa
- Over 260 river basins are shared by two or more countries mostly without adequate legal or institutional arrangements

In the future, service water and rainwater utilisation can back up the water supply in some countries. Resolution methods can be differentiated into two groups depending on the country or region [7]:

Group 1 contains predominantly developed nations with an existing infrastructure:

- Drinking water substitution in the building services engineering
- Load relief of the existing combined/gravity sewer systems
- Load relief of the existing waste water treatment plants
- Water retention as a preventive measure against urban floods
- Water for agriculture
- Water for trade and industry
- Back up of the local drinking water supply

Group 2 contains predominantly developing or newly industrialising countries (NICs) with little developed water infrastructure:

- Back up of the regional water supply/basic sanitation
- Water for agriculture
- Water retention as a preventive measure against urban floods

Countries belong to group 1 from Europe, North America, East Asia and Australia which may use service water and rainwater as a supplement to the already existing systems. In countries which belong to

the second group, rainwater utilisation can be used cost effectively for the basic supply mainly in rural areas.

These themes are represented world-wide by the International Rainwater Catchment Systems Association IRCSA which was founded in 1991. The aim of this organisation is the promotion of rainwater utilisation on a technical, scientific, planning and educational basis. The IRCSA is represented by eight directors and 41 national representatives distributed in all of the continents.

ASIA

PACIFIC ISLANDS: HEAVEN'S WATER HARVESTED FROM TREES

Asia has a special tradition and culture when it comes to rainwater. On Jeju-Island south of Korea and on Miyake, a volcano island in the Pacific about 200 km south of Tokyo, rainwater is harvested from trees. For this purpose, many strings with interwoven ends hang down from trees. Water trickles over this meshwork into a gutter which is directed into a cistern or a jar.

The indigenous people of Miyake use the tap water of the newly installed centralised drinking water supply system only to conserve their cistern reserves. With the hygienically clean municipal tap water which smells strongly of chlorine, they only flush their WC, irrigate their garden or use it for the washing machine.

JAPAN: DISASTER PROVISIONS

Japan is one of the developed countries in Asia who fostered an intensive international exchange in the field of rainwater utilisation from the very beginning. The activities of the administration of Sumida-City are internationally well known and have been recognised since the first rainwater utilisation conference in Japan in 1994. At the World Congress "Global Cities 21" in 2000 in Dessau, it received a distinction for its activities.

In the Rainwater Museum of Sumida, national and international projects are presented and products exhibited which come partly from Germany. In the past few years, the number of urban buildings in Tokyo utilising rainwater has increased considerably from three plants in 1970 to about 1000 in 2003. The city advises and supports residents and firms in the planning and installation of rainwater plants. Newly constructed public facilities must collect and use rainwater. Other Japanese cities are following in their steps.

Besides rainwater utilisation in the building services engineering, a focal point in Japan is disaster provisions in earthquake events [6]. Topics like "Treatment to drinking water" and "Water storage for firefighting" are thus strongly promoted. Some fbr member firms are already represented in Japan with their products.

Fig. 2
ROJISON IS A RAIN WATER TANK WHICH IS ACCESSIBLE FOR THE PUBLIC IN THE MATTER OF A DISASTER

Foto source: König

SOUTH KOREA: FLOODS AND DROUGHT

South Korea is rated by the UNO as a country with a water shortage. Measures which conserve drinking water resources are especially important. Flood protection in this country also enjoys the same priority. Strong precipitations within very short time periods always result in heavy floods. Public institutions and universities are developing suitable measures. In addition, rainwater utilisation in buildings plays an important role as part of the rainwater retention measures.

Currently a government programme is being developed which will accommodate future construction projects for the installation of retention reservoirs. Due to the uneven distribution of rainfall with long dry periods, water recycling measures such as greywater recycling, are becoming part of a sustainable water management [4]. The current low water price and flat rates which do not follow the polluter-pays-principle, are still a hindrance for an effective implementation.

CHINA: ENVIRONMENTAL EDUCATION AND OLYMPIC GAMES

Prevailing water scarcity dominates in the high density area of Beijng as well as in other parts of North and West China. Groundwater recharge, efficient drinking water supply and the economical use of water are very important issues in these regions. During the past 10 years, the groundwater table sank 10 meters and in some areas even 20 meters. Currently, priority is given to decentralised rainwater management systems and the multiple use of non-faecal waste waters from residential areas. Exemplary results have already been presented within the scope of an EU project in Beijng [10] [11].

Precisely Peking needs at the present time compensatory measures since in connection with the construction works for the Olympic Games 2008, new sports and residential areas with the corresponding infrastructure are emerging at a very high speed.

INDIA: LOW COST

Traditionally, rainwater has been the basic provision of the population in India before the colonial power England supplied the country with centralised

drinking water supply systems. In the meantime, local community initiatives revert to the well established decentralised concepts. The Centre for Science and Environment (CSE), an independent organisation, which supports and promotes rainwater utilisation in India through several measures, offers courses continuously in the different regions of India. The adapted technology for community self-responsibility, which means on implementation and operation instructions, is documented in the Book "Making Water Everybody's Business" [12]. The CSE received the internationally renowned Stockholm Water Prize 2005 for its commitment.

Rainwater distribution varies from 100 mm in the north-west deserts to 15,000 mm in the mountains of the north-east. Rainwater harvesting has supported agriculture in India for a long time. In addition to that, there is a demand for novel methods for decentralised water supply systems in urban areas. Large investments in residential construction programmes for the coming years in Mumbai (Bombay) are an answer to the continuing migration into the cities. Due to the strong population growth, urbanisation as well as increasing commercial activities, India has been ranked by the Food and Agriculture Organisation of the United Nations (FAO) as one of six countries with a significant future water shortage. Today, comprehensive government programmes are promoting a water-saving building services engineering.

AUSTRALIA: COMMITMENT TO RAINWATER UTILISATION

In Australia, a considerable expansion in the service water and rainwater utilisation is anticipated for the next years. In Sydney, private households consume about 70% of the total drinking water requirement. The government of New South Wales began action by enacting ordinances and propagating massive water-saving campaigns in order to reduce the water consumption. One part of these measures is the Building Sustainability Index, BASIX, a programme which incorporates rainwater utilisation among other issues. Since October 1, 2005 all new buildings have to be constructed according to the BASIX-Standard. This implies that rainwater utilisation plants are becoming a must.

Rainwater has been used for a long time as a drinking water resource in Southern Australia. Likewise, it is common to use rainwater in "hot water systems" (building services systems for water heating) for personal hygiene. Long-term, scientific investigations on the impact of rainwater used as drinking water have been available in Australia since 2001. The risk of intestinal diseases has been rated as very low [5].

Water suppliers and public health authorities in Australia promote water-saving measures such as rainwater and greywater utilisation on a wide basis. This will considerably enhance the development of service water and rainwater technology. A special case was the application of rainwater technology in WCs in the Olympic Village in Sydney in 2000, in which the athletes lodged [6]. A spectacle in itself was the action of the Australian Airlines Quantas who filled bottles with rainwater from Tasmania and distributed them as a delicacy among its passengers.

AMERICA

BRAZIL: ONE MILLION CISTERNS

Problems are featured on the one hand by the dry north-east and on the other hand by megacities like Sao Paulo on the coastline, which is repeatedly afflicted with typhoons with a high precipitation [15]. Due to climate changes, the clouds rain down over the big cities, so that the drinking water reservoirs in the highlands remain empty. Governmental agencies have reacted and imposed the construction of rainwater reservoirs for roof surfaces above 500 m^2. Due to the threatening water shortage also as a result of the high water consumption in the cities, rainwater utilisation is becoming more popular.

In the North of the country, the government launched a one-million cistern programme. With this, a basic water supply should be established for a wide population group.

THE CARIBBEAN: TAX REDUCTION FOR CISTERN CONSTRUCTION

On Haiti, where only a small part of the population have access to the public drinking water supply, the whole water requirement is traditionally covered by rainwater cisterns. Freshwater reserves are not available on the island. In the capital Port-au-Prince where most of the population live, water from tank lorries can also be bought to fill the cistern. However, the costs for this water exceed the contingency of the family budget. Also in Bermuda, Antigua and Anguilla it is self-evident to use rainwater from cisterns for drinking purposes.

On Barbados, there is an obligation in new buildings to set up appropriate cisterns dependent on the

Fig. 3
IN THE DOMINICAN REPUBLIC RAIN WATER SUBSTITUTES DRINKING WATER AND IS DIRECTLY LED TO THE KITCHEN WITHOUT THE HELP OF A PUMP

Foto source: Götsch

Foto source: König

Fig. 4
TREATMENT OF WOODEN ROOFS IN CANADA WITH FIRE RESISTANT MATERIAL RESTRICTS THE USE OF RAIN WATER

area of the building. The costs can be set off against tax liability [6].

NORTH AMERICA: CRITICAL ROOF MATERIAL

An increasing interest in rainwater utilisation can also be identified in the USA and Canada. Storage technology is so far available, however, other remaining components do not conform with the German standards and are still in the initial stages of development [3]. A lack of environmental awareness and across-the-board billing methods during consumption measurement in buildings are the causes for about three to four-fold higher water consumption than in Germany. Other reasons are partly the lower construction standards in the house services and sanitary engineering.

The high requirements of the currently much demanded LEED-Certificate for buildings may find a remedy in the long term. Special commitment to rainwater management is known from the US States of Maine, California, Oregon and Washington. Rainwater utilisation for irrigation is popular in Texas. The American Rainwater Catchment Systems association ARCSA is based there as well as a commercial filling station for rainwater for use as drinking water. The bottle labels have been humorously designated with "fresh squeezed cloud juice". The source of origin is the Dripping Springs.

In Canada, the wood shingle roofs which are being treated with fire resistant materials in compliance with guidelines from the insurance companies, influence the quality of the draining rainwater. The same influence from fungicides can be seen in asphalt shingle roofs [3]. Under the aspect of environmental protection and the improvement of the water quality for rainwater utilisation, a rethinking is urgently required. In the coastal regions of the Atlantic and the Pacific, rainwater is often utilised as a drinking water substitute although these roof materials are widely spread.

AFRICA: HELP FOR SELF-HELP

Rainwater utilisation is an option for a decentralised water supply or a supplement to the existing water infrastructure. A product transfer, for example from Germany, is actually only in cities of the northern coastal regions with a water infrastructure partly available, possible. This is presently being investigated within the scope of the Zer0-M EU project for Egypt, Tunisia and Morocco [7] with fbr participation.

In the Harambee culture in Kenya, women are responsible for the community infrastructure. They construct cisterns above the ground made from local concrete with the help of church organisations from Germany [6] and with governmental aid from New Zealand [9].

EUROPE

Due to the extensive market development and about 80,000 plants produced yearly, Germany is as before the leading country in Europe playing a significant role in the development of service and rainwater utilisation. Developments in the field are also found in Austria, Switzerland, Belgium and Denmark. The popularity of rainwater utilisation depends on the water price. The higher the price, the better the amortisation of the plant. Denmark (1.84 Euro/m^3) and Germany (1.73 Euro/m^3) have the highest costs and according to the National Consulting Group NUS, are world leaders.

Further markets are developing slowly in France, Great Britain (foundation of the Rainwater Harvesting Association UKRHA, 2004), Eastern Europe and Northern Italy.

GERMANY: WORLD-WIDE IMPULSE

Through the International Rainwater Conference 2001 in Mannheim, the fbr contacts have considerably widened. Over 400 participants from 68 countries met for the first time in Germany in order to amply discuss the role of rainwater utilisation in settlements and urban developments.

From press releases it can be seen that Germany, like other developed countries, can hardly maintain the widely-spread conventional system of combined/gravity sewers in the long run. In a current state-wide study, the German Association for Water, Wastewater and Solid Wastes (DWA) estimated the costs for the rehabilitation of the sewer system at about 50 to 55 billion Euros [2]. The Frauenhofer Institute ISI in Karlsruhe forecast that in a few decades, the drinking water quality cannot be guaranteed anymore with the conventional structures of the water supply systems. Assistance can be brought about by shifting the drinking water "production" to the consumer. Raw water which then flows in public supply networks will consist largely of rainwater similar to the pilot project in Knittlingen [13].

It is quite clear that rainwater harvesting and water utilisation have gained internationally in significance.

Germany is leading in this field and defines the trend for technical standards, public relations, advanced training and system dissemination. fbr firm members are increasingly exporting their products with a great deal of success. In order to accommodate this fact, the fbr takes over the European office of the International Rainwater Catchment Systems Association, IRCSA, in 2006.

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Fig. 5
COMBI SYSTEM FOR RAIN WATER AND WELL WATER USE IN A RESIDENTIAL BUILDING IN TUNIS, TUNISIA

Foto source: Nolde