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Sustainable Development of Middle East Region

Zrównoważony rozwój krajów Środkowego Wschodu

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Abstract

The Middle East is one of the most important regions of the world. The United Arab Emirates act as the leader in ensuring a sustainable and safe future for that area, and the whole planet. The economic development of the UAE is driven by securing clean energy, development of new technologies, access to water, stimulating employment of high-value specialists, safeguarding social welfare and combating poverty. An exemplar of a global model of sustainable development in urban areas is Abu Dhabi Masdar City – one of the most eco-friendly communities in the world. The ground-breaking projects that have been implemented in Abu Dhabi prove that the UAE set trends when it comes to utilisation of renewable energy sources and mitigation of the effects of climate changes in the region. The Middle East countries, including the UAE, recognise the tremendous role played by the society in protecting the environment and preserving it for the generations to come. The governments of those states believe that it is just as important as the activity of business leaders and the public administration. Educational programmes aim to instruct and inspire children and teenagers so that the environment could have a sustainable future.
This article presents some aspects of the UAE's economic development as well as the controversial social context and pro-environmental initiatives in the field of renewable energy sources, saving water and waste management.

Key words: sustainable development, Middle East, United Arab Emirates

Streszczenie

Środkowy Wschód jest ważnym regionem na scenie światowej. Zjednoczone Emiraty Arabskie pełnią rolę lidera w zapewnieniu zrównoważonej i bezpiecznej przyszłości dla regionu i dla świata. Rozwój gospodarczy ZEA opiera się na pozyskiwaniu czystej energii, rozwoju nowych technologii, dostępie do wody, tworzeniu miejsc pracy o wysokiej wartości, bezpieczeństwie socjalnym i walce z ubóstwem. Przykładem globalnego modelu zrównoważonego rozwoju obszarów miejskich jest jedna z najbardziej ekologicznych społeczności na naszej planecie, Abu Dhabi Masdar City. Przełomowe przedsięwzięcia w Abu Dhabi wskazują na to, że ZEA są pionierem w wykorzystaniu odnawialnych źródeł energii i łagodzeniu skutków zmian klimatycznych w regionie. Kraje Środkowego Wschodu, w tym Zjednoczone Emiraty Arabskie, zwracają uwagę na ogromną rolę społeczeństwa w ochronie środowiska i zachowania go dla przyszłych pokoleń. Rządy tych państw uważają, że jest to równie ważne jak znaczenie liderów biznesu i administracji publicznej. Program edukacyjny zakłada wykształcenie i inspirowanie młodych generacji w celu zapewnienia środowisku zrównoważonej przyszłości.
W artykule przedstawiono aspekty rozwoju gospodarczego ZEA, kontrowersyjny aspekt społeczny i inicjatywy proekologiczne na polu wykorzystania odnawialnych źródeł energii, oszczędności wody i gospodarki odpadami.

Słowa kluczowe: zrównoważony rozwój, Środkowy Wschód, Zjednoczone Emiraty Arabskie

Introduction

The main objectives of sustainable development are making sure that the needs of the present are met without compromising the ability of future generations to meet their own needs, but also providing the society with a long-term perspective on development prospects (United Nations, 1987). This concept is often presented graphically as three overlapping circles (Figure 1).

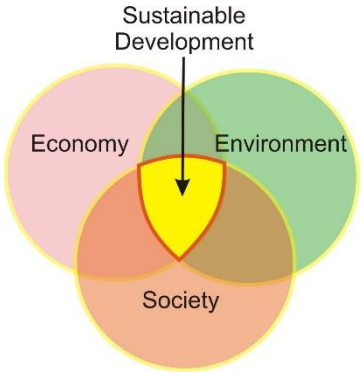


Figure 1. Three pillars of sustainable development: environment, economy and society (own study).

Seeking harmony, the effect of which is sustainability of development, is achieved through paying special attention to protecting the natural environment and ensuring social growth potential that follows economic growth. Protection means care for the natural environment and its resources so that they could be used – in an undeteriorated state – by future generations (Biedrawa, Sobczyk, 2011). This means focus on education, healthcare, safety and proper living conditions of human beings so that the social growth potential of future generations is preserved. In this way one can provide protection of rare assets and resources, thus making it possible to maintain sustainability of development.
What are the prospects for ensuring such form of development in the United Arab Emirates? To begin the discussion the author will give some general information about this country.

1. Description of the United Arab Emirates

The state of the United Arab Emirates (UAE) has a surface area of 83,000 square km. The dynamic development of the UAE began in the late 1960s, when abundant deposits of crude oil were found there. It was when its small, rather unimportant cities turned into powerful metropolises. The country, established in December 1971, once the Brits left its territory, is a federation of seven emirates. The decade of 1970-1980 witnessed rapid industrialisation of the cities: a network of motorways was built along with airports and numerous industrial facilities, such as aluminum works in Dubai. The location of Dubai on the route linking Europe and the Middle East with the countries of Southern and South-Eastern Asia helped to augment its commercial strength, e.g. by promoting re-exportation.
The demographic growth in the cities has been outstanding. Since the 1950s the population doubled every decade. This rapid change results from the influx of people attracted by job offers and availability of consumer goods. There are three times as many men as women. This is because many foreigners are hired as factory and construction workers.
In 2013, there were 9.2 million people living in the UAE, of whom 1.4 million are local residents and the rest – foreigners. The UAE are highly diversified nationality-wise: over 50% of the population are Hindu, while the rest comprises immigrants from Pakistan, Bangladesh, Sri Lanka, and the Philippines (Czopek, 2012). The country's migration balance is 21.7 – the highest in the world. Approx. 88% of the population lives in the cities. The average life span is 77 years, which is longer than in any other Arabic country.
Islam is the most popular, official state religion. The government supports the policy of religious tolerance and does not interfere with the activity of non-Muslims. 76% of the population are Muslims, 9% – Christians, 15% are followers of other religions (mostly Hinduism).

2. Sustainable development in the United Arab Emirates

As explained above, the concept of sustainable development is based on three pillars: economic, social, and environmental. Therefore, we should analyse each of them in the context of the situations that can be observed in the UAE.

2.1. Economic pillar

The economic development is primarily based on GDP growth, improving the situation of the society and increased cultural activity. A unique feature of the policies of the federal government and the emirates is implementation of a new vision of state's economic development. It mostly focuses on two objectives: modern technologies and raising the importance of science and education, necessary to implement advanced technologies and management methods. The UAE strive to develop their processing industry (petrochemicals, iron and aluminum, building materials industry), using domestic energy resources and raw materials. In not so distant future their power industry will use only renewable energy sources. Just as important are tourism and financial services – their level meets the most stringent global requirements (*Ministerstwo…*, 2012).
The UAE ranks fourth globally in terms of oil deposit abundance and 17th in terms of natural gas. Despite a succession of oil price drops, global loan crises and limited sources of investment funding, the

UAE witness a diminishing inflation risk combined with dynamic investment-construction activity, especially in the transport sector (underground, bridges, motorways, communication nodes, bus rolling stock, airports and ports, special economic zones) and the power sector (power plants and transmission lines). Abu Dhabi – the most powerful emirate in the economic sense – generates 56% of domestic product. This is where 95% of UAE's oil and gas extraction takes place. The wealth of Abu Dhabi is the foundation of the entire economic system of the emirates and of the state's economic policy.

The enormous deposits of oil and gas located in Abu Dhabi, in conjunction with its capital reserves, which the financial bodies of the emirate transfer abroad, are positive factors when it comes to the UAE's creditworthiness as a state. Since 2009 the budget has had a fully sustainable form: no surplus and no deficit either, which is an indicator of strong economic foundations. If an assessment was made of UAE's economic prospects, it would be a moderately optimistic one. The value of the gross domestic product is mostly composed of the oil and gas industry (30%), processing industry (15%), services (14%) and construction (11%).

Foreign trade is a key component of the UAE's economic development. Almost half of the value of export is oil, natural gas and petroleum products. Oil is exported mostly to Japan, South Korea and China. 30% accounts for re-export of imported goods, which the remaining percentage value is fish and dates. The emirates are the leading exporter of primary aluminum in the world (Trade Promotion, 2014).

The UAE's position as one of the largest trade hubs in the Near and Middle East is a result of their liberal trade policies, especially with respect to import and export. The excise on most products is only 5%. Customs procedures are easy; they are handled by computer systems. They reflect the policy aimed at supporting export, and in particular – re-export, which is so important for the emirates (10% of global gold trade goes through Dubai and there are over 600 jewellery shops in the city selling gold products).

A characteristic feature of the UAE's export policy is foreign trade in the so-called free zones. Almost 80% of exported products other than hydrocarbons come from such zones. The economic function of large urban centres in the UAE has been continuously growing. The level of local economic development manifests itself in investment attractiveness, number of international companies that have their branches in the cities, the number of foreign investments, development of new technologies. To meet those challenges the Dubai Silicon Oasis was established – a special zone intended for hi-tech companies manufacturing electronics and semiconductors. Each of the companies active in the field of new technologies is entitled to tax reliefs and exemptions.

The construction industry is the fastest growing industry sector. Apart from apartment buildings, skyscrapers and new motorways, a particularly impressive project is the construction of artificial islands (Palm Jumeirah, Palm Jebel Ali, Palm Deira, The World). A striking feature of the large cities in the UAE is their flamboyance: there are no architectural rules and limitations that cannot be broken. Buildings and projects amaze tourists with their unprecedented luxury (Photo 1) and originality (Photos 2, 3).

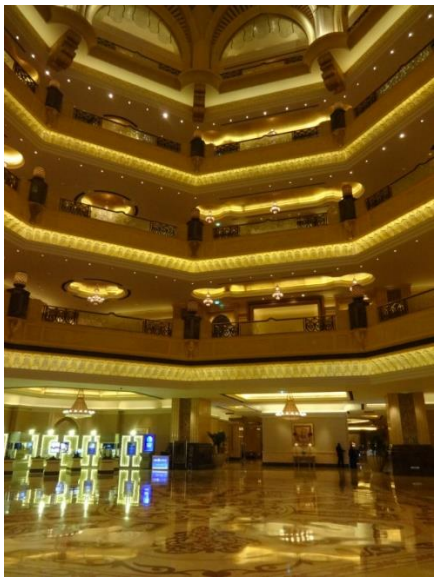
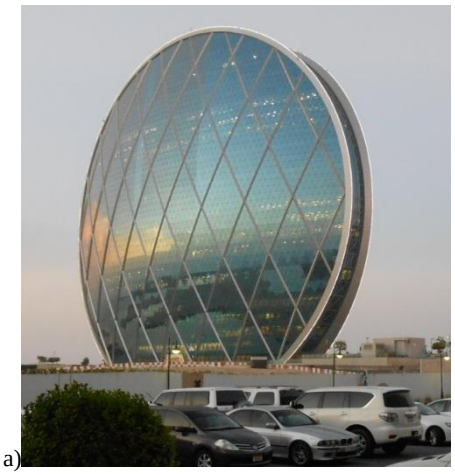


Photo 1. 7-star Emirates Palace Hotel in Abu Dhabi (photo by W. Sobczyk)

Photo 2. Address Downtown Dubai (photo by J. Niedzielski)

a)



b)

Photo 3. Architecture of Abu Dhabi, a. Aldar Headquarters Building (photo by W. Sobczyk); b. Capital Gate (photo by J. Niedzielski)

In 2011, the UAE ranked 14th in the World Bank's Ease of Doing Business ranking (report by the *World Bank Group*). According to *MasterCard Global Destination Cities Index* Dubai is the 5th most popular tourist destination in the world (in 2013, 10 million tourists visited the city). Since 1980 the UAE have spent billions of dollars on infrastructure. The changes are particularly noticeable in the two large Arabic cities: Abu Dhabi and Dubai. In 2014, the Dubai Airport was ranked as the busiest airport in the world with respect to international traffic.

2.2. Social pillar

The first president of the UAE, the ruler of Abu Dhabi Sheikh Zayed Bin Sultan Al Nahyan, supervised the development of the Emirates and earmarked part of the profits from the sale of oil for education, healthcare and infrastructure (United Arab Emirates).

2.2.1. Education

From the 1960s, even before state's independence was proclaimed, a number of primary and secondary schools were built. The teachers were mainly immigrants from Egypt. Currently, the New School Model is the obligatory form of education, offering modern programmes and teaching standards. As part of the *New School Model*, thousands of licensed teachers were hired from English-speaking countries (USA, UK, Canada, Australia, New Zealand, and South Africa).

The education system comprises primary schools, junior high schools, and high schools. Arabic is the language of instruction, but English has special importance as the second language. There are very many licensed private schools operating as well. Since 2005, the Abu Dhabi Education Council (ADEC) has been in charge of issuing licences and supervising private schools. In the Abu Dhabi emirate itself there are 265 public schools, 185 private schools and 18 universities (Abu Dhabi Education Council). Public schools in the UAE are free of charge only for the country's citizens. Sex segregation is obligatory in all public schools.

Even in 2007, there was a surprisingly high percentage of the illiterate in UAE (91%). Currently, thousands of citizens are receiving informal instruction in 90 adult education centres spread across the country. The government of the UAE is very concerned with improving the level of education and scientific activity. A number of influential research centres have been established, e.g. CERT Research Centres, Masdar Institute of Science and Technology, and Institute for Enterprise Development.

2.2.2. Healthcare

One of the initial pro-social steps was opening the first hospital in 1950 with the help of the Brits. It was a momentous event for the local community, as until then it had been virtually impossible to see a doctor, while many patients were forced to travel hundreds of kilometres to receive medical help (Czopek, 2012). However, a great number of health centres have been built, and many initiatives have been launched to alleviate this problem. A common vaccination programme has been implemented along with health-oriented education.

In 2008, the local Ministry of Health announced a new strategy for the healthcare sector. The main objective of the healthcare programme is unification of health policies and improving availability of doctors at affordable prices. Plans assume the construction of even more hospitals and health centres. Foreigners and their families are obliged to have health insurance. The UAE's healthcare system boasts a very

high standard – superior to anything else that is offered in other Arabic countries in the Persian Gulf. It is a strong incentive for many tourists who come there specifically to undergo plastic surgery, cardiac surgery, spine treatments and dental services.

2.2.3. Labour law

The provisions of law applying to the recruitment of foreigners are obligatory across the country. 91% of the local workforce are foreigners. Citizenship is available to individuals who have lived in the UAE for 20 years, have a clean criminal record, and speak fluent Arabic. However, today the process of granting citizenship is a complex one. For this reason many foreigners are considered *bidoon*, that is *stateless*. Very few foreigners have received full citizenship – some have lived in the UAE over 50 years. Since immigrants are not recognised as legitimate citizens, they receive no state benefits and are entitled to no workers' rights. The locals appreciate positive discrimination during recruitment – they are to be offered jobs as the first ones. This is the result of the governmental programme that obliges companies to reduce the number of foreign employees. This is meant to stabilise the labour market and protect the rights of the Emirati citizens who are a minority in their own homeland. On the other hand, the highly accommodating social welfare and benefits offered by the government discourage many locals from taking low-paying jobs, especially in the private sector (Human rights).

A prerequisite for being employed in the UAE is obtaining a work visa. Your future employer, or the party commissioning you a specific job, acts as your sponsor. An employer or ordering party may only be an Emirati citizen or a company registered according to the local law. The resident visa provided by the employer is valid through 2 years. Service provision requires having an Emirati majority shareholder as well as buying out a renewable 12-month license (*Ministry*…, 2012).

2.2.4. Human rights

In 2005, a federal court system was introduced in the UAE. The court structure is composed of three divisions: civil, penal and Sharia. In all emirates there are first instance courts and appeal courts – both federal and local. The UAE are criticised for breaching human rights, and also for the role played by Sharia code in the state's legal system. In the UAE it is forbidden to criticise the government, state officials and members of the royal family. Mockery, criticisms or making fun of the state and religion are punishable with prison (under Sharia law). The citizens have no right to form political parties. Sharia courts have sole jurisdiction over criminal cases, including adultery, robbery, alcohol consumption, battery, drunk driving, and drug trafficking. The provisions of the Islamic law also cover the issue of compensation for a murdered family member (blood money), e.g. the family of a victim of a car accident receives compensation from the perpetrator. The Sharia law regulates the civil status of people: family matters, marriages, divorces and childcare.

In all emirates (except for Dubai), a valid sentence for such offences as adultery, premarital sex and alcohol consumption is flogging (40 to 200 lashes). A few Muslims have been punished with 40 lashes for alcohol consumption in Abu Dhabi. The penalty for kissing in public places is 80 lashes or in some cases – deportation. In 2007-2013, quite a few persons were punished with 100 lashes for pre-marital sex in the UAE. A part of the local laws is the dress code, which is the obligation to wear modest clothes. In the UAE there are regulations on proper outfits fixed near the doors to most shopping malls. Women are obligated to cover their arm and knees, while sleeveless blouses and shorts are prohibited. Visitors to a mosque are expected to wear inconspicuous clothes. It is forbidden to dance in public area.

Stoning to death is a legal punishment in the UAE. In 2006-2014, a few persons were sentenced to death by stoning for adultery. Apostasy (public and complete denunciation of Islam) is also punishable by death. Likewise, homosexuality is another *crime* that results in a death sentence. An Emirati person is not even allowed to shake hands with a homosexual. A penalty for sodomy is up to 14 years in prison. According to Sharia law, limb amputation and crucifixion are valid penalties in the UAE.

During Ramadan, eating, drinking, and smoking in public are forbidden between sunrise and sunset. This does not apply to pregnant women and children who are allowed to eat. Under Sharia law, the provision applies to both Muslims and followers of other religions (Sharia Low).

Human Rights Watch claims that civil courts apply elements of law that discriminate against women (United Arab Emirates). Emirati women need permission of their male guardians to marry or remarry. Means of public transport have separate areas for women and men (Photo 4). The same goes for state offices. In any other situation a woman must accompany a man walking behind him (Photo 5).

Photo 4. Separate zones for men and women on a public bus (photo by W. Sobczyk)

The author of this paper will not comment on the merits of Sharia law. She is of the opinion that discussing issues related to religion calls for extreme subtlety and prudence.

Photo 5. In Arabic countries women follow men (photo by W. Sobczyk)

According to the Freedom House annual report, every year since 1999 (when the report was first published online) the UAE have been assessed as a country without freedom and in 2013 Amnesty International accused the UAE of restrictive approach to freedom, however the UAE have not yet witnessed riots, religious tension and social unrest motivated by a desire for a change of the economic and political system.

Another problem is the way the UAE treat wage workers, mostly immigrants from South Asia – often described as a modern version of slavery. The foreigners have no employee rights; they may not form trade unions, organise themselves or go on a strike.

Although the local Constitution provides for fair treatment of all individuals regardless of their race, nationality, religion or social status, there are very few rules of law in the UAE that would prevent discrimination within labour law.

2.3. Sustainable environmental development

The economic development of the UAE is accompanied by intensive activity in the area of environmental protection, which is reflected in the organisation of regional conference addressing this issue. As part of the Sustainable Development Week in Abu Dhabi (January 2015), the country was the host of the World Future Energy Summit (WFES), the International Water Summit as well as of the EcoWaste 2015 conference.

2.3.1. Sustainable energy management

The Middle East is a region boasting enormous potential in terms of renewable energy, which has not been utilised to date. With the abundance of crude oil and natural gas, the UAE got involved in the development of modern solar power technologies. This commitment only proves the understanding of the importance of investing in sustainable future.

The International Renewable Energy Agency (IRENA) has its headquarters in Abu Dhabi; it is the first inter-governmental organisation of this kind in the Middle and Near East. The Agency started tackling environmental issues with its own headquarters. The building of IRENA headquarters uses 64% less energy and 48% less water than a typical building in Abu Dhabi. The air-conditioning system recuperates 75% of energy and uses it to cool the air coming from the outside. The building structure was made from recycled materials (steel, aluminum). The aluminum facade reduces solar flares and absorbs heat. With durable construction materials and energy-efficient technologies, energy consumption is substantially lower.

The Abu Dhabi authorities decided to earmark USD 15 billion for reduction of CO_2 emission and for the construction of Masdar City, i.e. a green, pedestrian-friendly city. All these efforts are part of the objective to reach a 7% share of renewable energy by 2020. Moreover, the objective of the Dubai emirate is to have a 1% share of solar energy in its total power production by 2020, while 5% in 2030. Similar objectives in the area of renewable energy were established by other Middle East states: Saudi Arabia, Kuwait, Oman, and Bahrain.

All newly-built structures and residential buildings must comply with stringent requirements with respect to energy and water efficiency as well as sustainable construction.

Extreme temperatures and high humidity in the UAE pose a challenge for both real estate owners and the environment. In the last decade the demand for electricity in the UAE doubled (from 35 billion kWh to over 70 billion kWh). The costs of air-conditioning amount to 70% of the total power consumption in the UAE. That is why the search for alternative cooling solutions is a top priority (*Sustainable summer*, 2014).

Air conditioning units require constant maintenance and regular cleaning to be able to operate at their maximum capacity and to prevent health problems of their users.

Architects today use the solutions typical of the traditional Emirati architecture in conjunction with natural ways of keeping buildings cooled (awnings and blinds). They apply insulating materials, such as stone and ground, which absorb significant heat amounts throughout the day. They also introduce innovative ideas which help sunlight reach buildings in winter, but block it in summer. The east-west orientation of buildings is an effective way of avoiding heat surplus whilst simultaneously increasing wind flows.

The interiors of the apartments in the Al Bahr skyscrapers remain cool due to the largest computerised elevation ventilation system in the world (Photo 6). The solution was inspired by the traditional Arab architecture from the 14th century with its dominant, geometrically designed wooden screens called

mashrabiya, which means to drink or to absorb. The cluster system on the Al Bahr Tower, powered with a tracking system, opens the shaded area and closes the exposed area following the Sun's path (Al Bahr Towers, 2014).

Photo 6. Al Bahr Towers. A view of the buildings from the north (photo by W. Sobczyk)

Given the Abu Dhabi longitude, sunrays can heat the external surface of windows to approx. 90°C. By shielding window panes from the sun, the screens keep the building cool, reduce flare emissions and maintain dispersed natural light. If this method is used, buildings require less artificial lighting while the costs of air-conditioning are lower by 50%.

Solar energy is used in many solutions. Even waste bins have photomodules to light advertisements at night.

In 2006, in one of Abu Dhabi districts, the construction of Masdar City commenced – a solar city of the future (Photo 7). At present there is a research institute and university there which serve as the centre of education for young scientists and engineers specialising in clean and sustainable technologies.

On a 22 ha plot in Masdar City, a photovoltaic solar power plant is located comprising almost 88,000 polycrystal modules (Photo 8). It is the largest network of solar power plants in the Near and Middle East (Masdar City, 2014). The solar panels installed on building roofs generated electricity already at the stage of Masdar City construction.

In some buildings on the university campus, elements of traditional Arab architecture were employed to facilitate effective ventilation and cooling of building interiors.

In Masdar City the maximum distance to the nearest transport node is never longer than 200 metres. The residents have additional comforts at their disposal, such as shaded streets, promenades, and paths. Centres of work, entertainment and recreation are near residential buildings to minimise the use of transport modes. The only vehicles that are run along established routes in Masdar City are eco-friendly cars operating with solar-powered lithium batteries (Photo 9). The vehicles ride along predetermined routes thanks to a magnet installed in their floors. Sensors ensure collision-free ride.

Photo 7. A model of Masdar City (photo by W. Sobczyk)

Photo 8. Solar panels on building roofs (photo by T. Niedzielska)

Photo 9. Station of eco-friendly vehicles in Masdar City (photo by W. Sobczyk)

Also wind power is employed in Masdar City. The wind tower (Photo 10 a, b) sucks hot air in, transports it upwards and releases it through chimney-like structures (Sustainable summer, 2014). The system facilitates building ventilation. This idea, based on traditional ventilation concepts, is used in both historical buildings and in modern architecture. An up-to-date version of the system is used in Masdar City:

the wind tower features sensors to maximise efficiency of capturing wind.
Once the investment is ready (2016), there will be 40,000 people living in Masdar City, while another 50,000 will commute to work or study there, learning about power solutions, green technologies and other aspects of environmental protection.


a)


b)

Photo 10. Wind well (a) and its inside from the bottom (b), Masdar City (photo by W. Sobczyk)

2.3.2. Sustainable water management

For the UAE water is more important than crude oil. About 50 years ago, in Abu Dhabi groundwater extracted with traditional methods was enough to meet water demand. The traditional methods of water extraction and transport were, and still are, energy-intensive, but they were used in a sustainable way in line with the local demand.
Now water is produced and consumed on a much greater scale. In 2012, the annual water consumption in the Abu Dhabi emirate was 3.4 billion cubic meters. Of this 62% was groundwater, 30% – desalted water, 8% – recycled water. Water is used primarily in agriculture, forestry and landscape irrigation (over 70% of general consumption).
The total demand by far exceeds the capacity of underground water supplies. In some cases, groundwater extraction is 25 times the natural production. If this does not change, the resources deposited during the most recent ice age (over 10,000 years ago), will soon be depleted (Facts, 2014).
Only 18% of groundwater can be used directly; a mere 3% is fresh water, under strict protection. As much as 79% of groundwater is saline water that must be treated before use. Desalting systems are primarily based on the thermal desalination technology (93%) through multi-step distillation (MSF); the remaining 7% of fresh water is produced with the reversed osmosis technology (http://rsb.gov.ae).
The processes of desalination and preliminary chlorination of seawater, along with the transport of concentrated brine, lead to serious disturbances in the sea ecosystem. Brine contains ions of copper, nickel and chromium, migrating from the distiller walls. Polyphosphate added as a descaling agent acts as a nutrient for algae, contributing to their blooming, resulting in water eutrophication (Shams, Aziz, Makkawi, 1994).
The share of groundwater resources is on the wane, salination is increasing, while the demand for water is growing. In Abu Dhabi the share of desalinated water in the total balance of used waters will be growing substantially. But the desalination technology is not a sustainable process and it poses a great economic and environmental challenge. Desalination is very energy-consuming, which is reflected in higher CO_2 emission. Brine from chemical desalination plants is pumped into the sea, becoming a threat to many organisms living in this ecosystem.
The countries of Middle East have other problems as well, namely the traditional methods of farmland irrigation are frequently ineffective and the use of desalted water contributes to enhanced salination of groundwater. This, along with excessive use of artificial fertilisers and pesticides in agriculture, decreases the productivity of already barren soil.
Given too intensive use of the Persian Gulf water, the use of municipal sewage as a source of fresh water is being considered. Sewage from households, offices and plants must undergo a multi-step treatment to eliminate hazardous chemical substances and bacteria so that the processed water could conform to stringent standards (Photo 11, 12) (Arafat, Ro'il Bilad, Kharraz, 2014).

Photo 11. Modern municipal sewage treatment plant on the Reem Island. Abu Dhabi (photo by W. Sobczyk)

Photo 12. Mafraq sewage treatment plant. Closed sedimentation fermentation chambers (anaerobic digesters). UAE (photo by W. Sobczyk)

There are many sewage treatment technologies available worldwide; however, they are very time- and capital-consuming (Borkowski J., Sutowska, Borkowski P., 2014). The United Arab Emirates are working on effective, high-performing and affordable systems of sewage treatment. At the Masdar Institute there is a research team developing a membrane for new generation membrane bioreactors (MBR). MBRs will offer a compact system for the production of high quality water in combination with biogas recovery. But the technology still needs further development. The biggest problem is the membranes which easily get clogged with growing microorganisms and algae. It is a continuous process preventing proper functioning of the membrane, which must be cleaned or replaced on a regular basis. This entails loss of membrane capacity, costs of chemicals use and the need to replace membranes. A MBR membrane which would not be prone to overgrowing would be a much more attractive alternative for water treatment, but it is still only a design. Currently the research focuses on the construction of a membrane of greater porousness and proper surface. The technology was tested on municipal sewage collected from Masdar City. The effect was fantastic: after one month the MBR membranes were still free from biological contaminants and in working order. It is enough to mention that traditional membranes in a membrane bioreactor must be cleaned or replaced once a day (Sabah, 2007).

The research results look very promising. This could be an interesting solution for the market of technologies of processing sewage into a source of fresh water in countries with low water resources.

Groundwater protection is one of the priority tasks in the countries of Middle East. The Environmental Agency of the Abu Dhabi emirate emphasises cooperation with partners to develop and implement pro-environmental policies and legal framework regulations. Monitoring and assessment of groundwater condition is performed on a regular basis. Permits for drilling groundwater wells are issued by a competent office in line with strict regulations (Law no. 6). Farms are subject to periodic controls with respect to the use and sale of groundwater and law observance.

In the UAE a number of projects are being implemented to manage water resources in a more effective way, e.g. construction of experimental sun-powered desalination plants, increasing surface areas of forests which are retention bodies for water resources, etc.

2.3.3. Sustainable waste management

The UAE government pays much attention to environmental protection and sustainable development issues, including integrated management of waste as well as production and sale of recycled products. The Tadweer Centre of Waste Management in Abu Dhabi implements the assumptions of the UAE environmental policy: Abu Dhabi Vision 2030. In particular it strives to maintain a safe and clean environment for future generations, while taking care of proper living conditions of the present generation.

In 2010, a new system of municipal waste collection and management was implemented in Abu Dhabi. It was installed underground in 115 places within the city (*Abu Dhabi launches*, 2014). The criteria for selecting those places included population density and weight of generated waste. Pedestrians, cleaners and owners of small shops on a given street may deposit their waste in the established spots. The system operation is based on electro-hydraulic replacement of huge, 20 cubic meter containers. There are eight smaller containers within them, fixed in a metal frame. The container is placed in an underground concrete chamber. The only element of the system that can be seen from the ground level is a steel receiving tank, i.e. a container where waste is placed.

The underground container features sensors which send the signal to the control room when the container is filled in 75%. With this, it is possible to collect waste in an effective and timely manner. Special waste collection vehicles pick the container up from the ground and replace it with an empty one. The monitoring system is a method of ensuring waste collection by approved users only, and it prevents unlicensed waste disposal. The system boasts many advantages: it eliminates odour, scavengers (including insects and rodents), and prevents accumulation of waste around the collection points. This, in turn, improves aesthetics of the surrounding area and creates a clean environment for the residents. Most certainly it also contributes to the reduction of the number of truck rides (lower fuel consumption).

A major problem of modern civilisation is electronic waste. The Enviroserve Corporation, based in Dubai, is the first and the largest service company in the Middle and Near East that manages electronic waste (e-waste). The company assets include the most cutting edge, environment-friendly technologies. It is a source of know-how and competence in the field of e-waste recycling in the Near East (Fleming, 2014). From the time – a decade ago – when the company collected 150,000 mobile phones in three months until this very day, when hundreds of tonnes of e-waste

are stored on landfills, Environserve has been consistently introducing technologies that make it possible for the countries in the Middle East to meet the requirements of environmental accountability. The E-waste Department offers professional, clean recycling of all types of e-waste: mobiles, cameras, laptops, servers, batteries, cartridges, etc.

Mobile phones are among the most prevalent modern technologies of the contemporary world. According to the studies of the International Telecommunications Union, over 5 billion subscribers use mobile phones all over the world (http://twojepc.pl). Each year a billion of mobiles are produced, but less than 20% of them are recycled in line with the United States Environmental Protection Agency (www.epa.gov). On average the length of using a mobile is 12 months; then they are discarded as new technologies offer improved functions and accessories. Mobile phones are a huge burden for the environment.

When stored on landfills, they may cause a leakage of substances containing heavy metals (lead, mercury, cadmium, nickel, arsenic), lithium and persistent bioaccumulative toxins. If they penetrate groundwater, adverse effects can be caused in human beings, including damaging the nervous system, infertility, cancer and disorders of the genetic code. Lithium in large amounts may initiate underground fires. In the countries of the Middle East all producers, vendors and sellers of mobiles are required to inform the buyer about the programme of used equipment collection.

3. Environmental education for sustainable development

Our planet, along with all countries and nations on it, is not able to sustain the level of consumption, emission and production of waste of the last 50 years. Each of us has their own role to play in these changes. Promoting a sustainable lifestyle of a society and development of clean technologies is an important task of environmental education. The survival of our planet is only possible if we can change our old habits into environment-friendly behaviour (Piecuch, Hewelt, 2013). Much is being done in terms of education to raise environmental awareness among the society members with respect to protection of groundwater; they are also being encouraged to abandon their wasteful attitudes towards the environment. The objective here is to preserve and protect shrinking water resources.

In the countries of the Middle East, one can observe a growing need for waste management know-how. Integrated waste management solutions are of crucial importance for the implementation of the sustainable development concept. Widespread environmental initiatives in waste segregation and recycling, combined with recycling optimisation, will untimely help us reduce the weight of generated waste.

The Waste Management Centre (Tadweer) offers educational programmes to a large number of students from various schools and universities as well as informs the entire society about the key actions the Centre takes. The educators of Tadweer organise workshops for the youth on public hygiene, environmental safety and effective use of colourful containers for waste segregation (Photo 13).

Photo 13. Examples of environmental education of the society: a key to bringing about a behavioural change – encouragement to segregate waste (photo by W. Sobczyk)

During the EcoWaste 2015 event, the Tadweer organisation presented an environmentally-friendly stand, 100% of which was made from recycled raw materials. To build the stand old steel structures were used, as well as containers collected from different regions of the UAE. The stand ceiling was crowned with 2,000 empty aluminum cans collected at shopping malls and schools; also, various 100% recyclable materials were used in the construction of the floor (Ecowaste, 2015).

Waste management is used in many sectors of domestic economic activity. The biggest amount of waste in the UAE is generated by tourism and retail trade. For this reasons the UAE is introducing a policy on auditing the economy branches where the volumes of generated waste (usually transported to landfills) may be significantly reduced. A wealth of guidelines is provided as well, covering such aspects as effective waste segregation. Discounts are offered to companies which collect and neutralise waste. Some companies have already introduced substantial changes to the way they manage their waste. For instance, the Farnek Company introduced the first binless office in the region, which is conducive to improving office culture and forms the sense of accountability among the staff for environmental advantages brought by recycling (Farnek, 2015).

In 2009, a strategic Master Plan was developed on water consumption. Actions were taken to reduce water consumption, which is one of the highest per resident in the world (The National, 2009). The government has launched a media campaign to encourage people to save water. This also applies to reasonable water use in free-of-charge toilets and showers (which are a very popular amenity). The emirates are

striving to maximise the use of water recovered from sewage.

The Ministry of Environmental Protection in the UAE initiates regional and international actions and networks to support learning and exchanging best practices (Environmental education, 2015). As a result of this, the desired standards of environmental education are reached. The projects are supported by introduction at schools and universities of award-winning environmental education programmes (for example: Enviro-Spellathon, Annual Environment Competition and Sustainable Campus Initiative). Enviro-Spellathon is one of the longest-running educational programmes in the UAE. The objective of the programme is to create an environmentally-aware generation. The point of this initiative is long-term education: from the youngest generations to university students – they should all be equipped with know-how and skills that will make them the leaders of sustainable development.

The Sustainable Campus Initiative is a federation of students-volunteers. It provides many environmental services on the premises of the Waterloo University campus in Dubai and outside. Its primary activity is education and issuing expert opinions. The main objective of SCI is to bring about behavioural changes in the society. SCI organises workshops, carries out fundraising, and offers consulting services to students and various environmental organisations.

Summary

The Middle East is an important region in global terms. The United Arab Emirates act as a leader in ensuring sustainable and safe future for the region and the world. The future-oriented projects implemented in Abu Dhabi and Masdar City prove that the UAE are a pioneer in using renewable energy sources and mitigating the effects of climate changes in the region. The utilisation of clean energy sources and new technologies, as well as creation of high-value jobs, testifies to the country's leading role in ensuring sustainable future for the region and world. In the first decade of the 21st century, environmental protection became a priority in the UAE. Rich countries invest in environmental education. Educational programmes provide instruction and inspiration to young generations to ensure sustainable future for the environment and preserve it for the future generations. Less well-off countries are striving to get rich, but forget that their greatest treasure is people, society, nation. A well-educated society, boasting high personal and environmental culture, guarantees economic development (Sobczyk, 2014). Environmental education, through adequate instruction, helps develop proper attitudes, behaviours and sensitivities; it promotes a sustainable lifestyle of the society and brings about a change of old bad habits. The governments of the countries in the Middle East, including the UAE, are aware of the fact that environmental education is just as important as business leadership and public administration.

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