

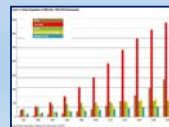
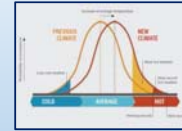
## HIDDEN THREATS IN CENTRALIZED WATER SUPPLY AND MODERN METHODS OF OVERCOMING THEM

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## WE ARE LIVING IN A RAPIDLY CHANGING WORLD

At present, more than 50% of the world's population is urbanized and faces many threats.



Examples of these threats are:

- Extreme climate change;
- Rise of megacities;
- Unprecedented mobility in communications;
- Unprecedented access to information;
- Terrorism.

## BUT FUNDAMENTAL HUMAN NEEDS REMAIN THE SAME

These needs are: clean water, fresh air, and organic food.

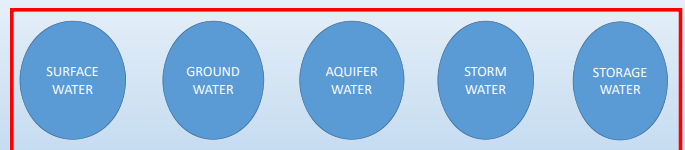


Water is the first need for life.

Safe and accessible water supply must be available to all people independently of where they live.

Much has been said about water, of water networks, of tap water quality. However something else can still be added.

## THE FOLLOWING MAIN SOURCES ARE USED FOR WATER SUPPLY TO CONSUMERS

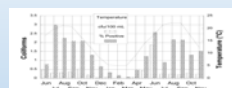


The water from each of these sources undergo treatment at DWT plants before being supplied to users through main and local water nets.

Let us consider the quality of tap water inside the nets of different sizes

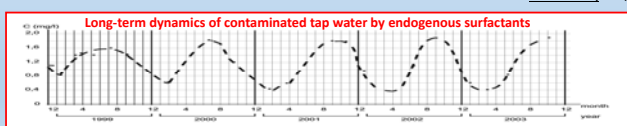
## IN BIG CITIES, TREATED WATER IS SUPPLIED TO CONSUMERS THROUGH LARGE NETWORKS

Tap water inside these networks are saturated by secondary arisen contaminants of biological origin, as shown below



E-coli reproduction in tap water

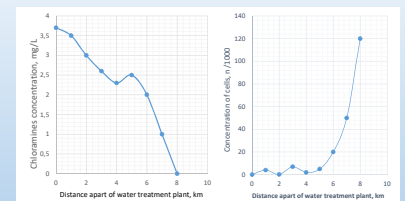
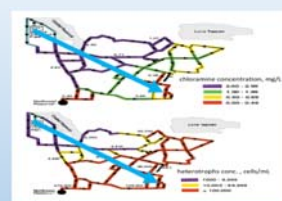
Lechevallier (2003)



Long-term dynamics of contaminated tap water by endogenous surfactants

V.S. Gevod (2009)

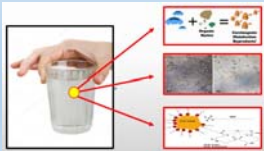
## BIO-POLLUTION OF WATER ALSO OCCURS IN SMALL NETWORKS



These are results of monitoring concentrations of chloramines and heterotrophic microorganisms in a limited area of the water distribution network in New Jersey (USA).

Woolschlager et al. (2000)

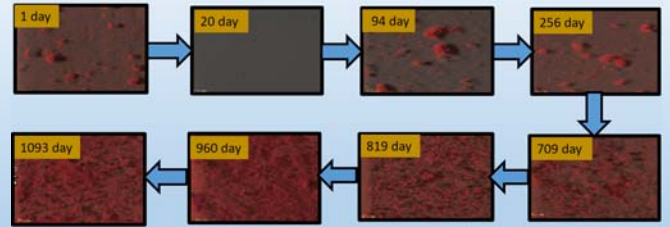
**THEREFORE, WATER MANAGERS AND USERS CANNOT BE SURE IF EVERYTHING IS FINE WITH THEIR WATER SUPPLY**



Hygienic quality of drinking water deteriorates during transport between DWT plants and consumers (end users).

This is due to the water distribution networks being large reactors, where a number of chemical and microbiological processes take place.

**BIO-CONTAMINATION OF WATER IS RELATED TO THE GROWTH OF BIOFILMS ON THE INNER SURFACE OF WATER PIPES**



The above illustrate the dynamics of biofilm growth inside of a model network, supplied with very pure water. First, the colonies of autotrophic bacteria appear – then, the heterotrophs.

Adam et. al (2003)

**MANY KINDS OF PATHOGENIC MICROBES HAVE BEEN FOUND INSIDE BIOFOULINGS**

This table shows the list of pathogenic microbes found in biofilms of water networks worldwide

Causative agent	Disease
Vibrio cholerae	Cholera
Shigella	Dysentery
Salmonella typhi	Typhoid Fever
Salmonella bongori, Samonella enterica	Salmonellosis
E. coli H7-157	E. coli infection
Campylobacter jejuni	Campylobacteriosis
Legionella	Legionellosis
Leptospira	Leptospirosis
Clostridium botulinum	Botulism
hepatitis virus	Hepatitis A and E



Seed matter of pathogenic microbes are always present in water sources, in soil and in the ambient air

**BACTERIAL COUNT OF 10<sup>9</sup> CELLS PER SQUARE CENTIMETER IS DETECTED IN BIOFILMS OF WATER PIPES**

Under stresses in water networks, the supplied water is saturated by plankton and scraps of biofouling released out of biofilms.

The scraps of biofouling, containing high densities of pathogenic microorganisms, create a danger of waterborne diseases spreading among consumers.

With increasingly stressful situations in the water supply system, we observe a higher probability of strong contamination of tap water by bio-hazard substances.



Olson, (1982)

**IMPORTANT NOTE**

The inner surface of water pipes represent an ecological niche for many kinds of bacteria, and the possibility of terrorist attacks on water supply systems becomes increasingly easier from year to year.

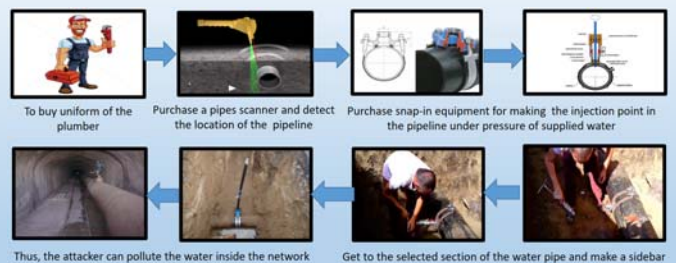
\*\*\*  
A good basis for this created by nature.

\*\*\*  
Currently, more than 1,000 microbiological laboratories in the world work with strains of pathogenic microbes.

\*\*\*  
The necessary materials and equipment to execute malicious actions are easy to purchase in trade networks

\*\*\*  
This is not fully understood by water managers responsible for water safety.

**AN INTRUDER COULD PERFORM A TERRORIST ATTACKS BY CARRYING OUT THE FOLLOWING STEPS**



All the necessary information on this subject is available on the World Wide Web

### REQUIRED INJECTING EQUIPMENT IS SHOWN HERE

These tools kit are enough to pollute tap water with neurotoxins

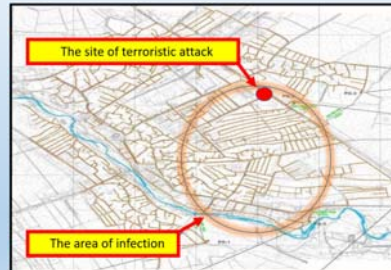


And this equipment can ensure the contamination of a large area of the water supply network through sewage microflora



All these goods can be bought by anyone in a retail chain, for an attack to be carried out

### THUS, THE SUBSCRIBERS OF A WATER SUPPLY SYSTEM CAN BECOME VICTIMS OF MALICIOUS ACTS



The greatest danger a biological attack could present on any given part of a water supply network is through the use of botulinum toxin.

When botulinum toxins get into human or animal organism, a dosage of about 100 ng/kg lead to rapid symptoms of severe poisoning and possible death.

### HOW CAN ANYONE PROTECT THEMSELVES FROM HIDDEN THREATS IN TAP WATER

There are two well studied and approved means

1 Reverse osmosis systems for domestic use.

Concentration of botulinum neurotoxin in influent water is 3,000–6000 ng/liter



Filtration rate is 4.5 liters/h

Concentration of botulinum neurotoxin in effluent water below of 30 ng/liter

2 Sand filters. (0.6–1.2 mm silica sand granules; column height, 20 cm; column diameter, 20 cm)



Filtration rate is 30 liters/h

Concentration of botulinum neurotoxin in effluent water below of 300–ng/liter

Horman et al. (2005)

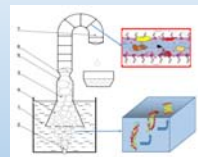
### IN THE LAST DECADE, AN INNOVATIVE, ECOLOGICALLY FRIENDLY WATER PURIFICATION SYSTEM HAS REACHED THE MARKET

This system consists of three functional units:

Advanced sand filter



Advanced flotation device

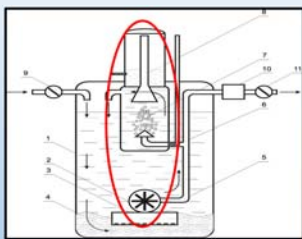


Advanced UV sterilizer



The principles of this system action are circulatory filtration, circulatory flotation and a final UV sterilization, leading to treated water as its output  
Георд В.С. (2007)

### THE PRINCIPLE DESIGN OF THE INNOVATIVE WATER PURIFIER



1 - unit case, 2 - centrifugal pump, 3 - drainage device, 4 - sand, 5 - pump inlet line, 6 - ejector of air, 7 - bubbling compartment, 8 - bubble-film extractor, 9 - water inlet, 10 - UV sterilizer, 11 - water outlet.

Surface-active admixtures of water are withdrawn from water bulk via the Bubble-Film Extractor.

Bacteria and viruses are inactivated when passing through UV sterilizer.

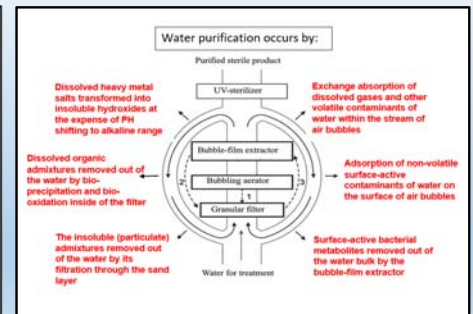
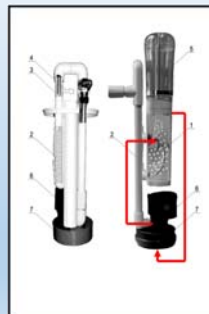
Neurotoxin lose its toxicity when adsorbed and dissociated onto subunits at the surface of air bubbles (stretching and pulling of the neurotoxin out of its toxic shape).

The solution of the toxin also loses active molecules when filtered through the sand load.

The innovation enhances the water purification efficiency in many times

Георд В.С. (2015)

### PHOTOS OF A FUNCTIONAL MODEL OF THE INNOVATIVE WATER PURIFIER, AND THE PROCESSES INSIDE IT

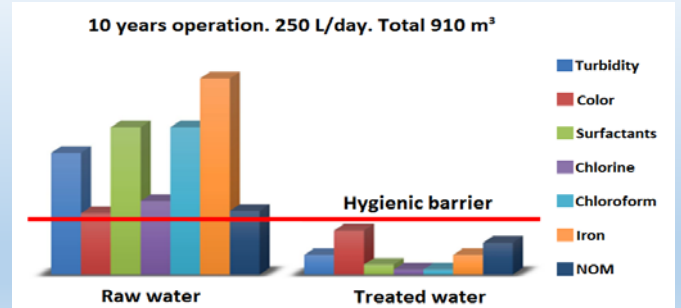


### EFFICIENCY AFTER THE PURIFICATION OF TAP WATER BY THE DESIGNED DEVICE

Parameter	Initial water	Treated water	Standard
Color, degree	20	< 20	20
Turbidity, mg/L	4	0.87	1.5
pH	7.25 ± 0.3	8.2 ± 0.1	6.0 ÷ 9.0
Residual chlorine, mg/L	1.2	< 0.6	0.8 ÷ 1.2
Chloroform, mg/L	0.15	Unfound	0.06
Tetrachloride, mg/L	0.006	Unfound	0.005
Aluminum, mg/L	0.24 ± 0.02	0.11 ± 0.001	0.5
Iron, mg/L	0.7	< 0.1	0.3
SAS, mg/L	1.5	< 0.025	0.5

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### WATER PURIFICATION EFFICIENCY OVER LONG TERM OPERATION



### ENVIRONMENTAL IMPACT

(Energy use, global warming potential, eutrophication potential, human toxicity, terrestrial and aquatic eco-toxicity potential, acidification, photochemical oxidation)



The comparison of two parameters:  
Global warming potential as measured by greenhouse gas (GNG) emission; at the production of each device, including their consumables from birth to grave (A), and electric power consumption of these devices (B).



A) GHG emission - 70 kg  
B) electric current consumption - 60 WT

A) GHG emission - 6 kg  
B) electric current consumption - 12 WT

### THANK YOU

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