Readers Insight
Publisher of open access books and journals

PJMLS

Print ISSN: 2707-4471. Online ISSN: 2707-448X

Review Article	Pak-Euro Journal of Medical and Life Sciences
DOI: 10.31580/pjmls.v4iSpecial.1802	Copyright © All rights are reserved by Corresponding Author
Vol. 4 No. Sp.1, 2021: pp. S126-S137	
www.readersinsight.net/pjmls	
Submission: December 27, 2020	**Revised:** March 06, 2022 **Accepted:** March 10, 2022

CONTAMINATED WASTEWATER IRRIGATION IMPACTS ON HUMAN HEALTH

Nazmeen Musa Khan[1], Arifa Bano[2], Ghulam Ishaq Khan[1], Fazal-ur- Rehman[1]*

[1]**Department of Microbiology,** University of Balochistan, Quetta, Pakistan
[2]**Department of Chemistry,** University of Balochistan, Quetta, Pakistan
***Corresponding Author:** Dr. Fazal-ur- Rehman. E. mail: fazal_bio@yahoo.com

Abstract

Water is the basic need of life and important practices in agricultural practices. Microorganisms are present in the irrigation water, from house hold and industries, factories are easy transferred to human through the consumption of these vegetables that has been grown with the waste water becoming the source of illness in many cases of food borne diseases. The leafy vegetables are more risky for the human and consumption of fresh leafy plants are suspectable to cause illness in human beings. Wastewater used for the irrigation contains both microbes and toxic heavy metals which cause toxicity. Industries waste contains microbes that are resistant to heavy metals which are used in common practice for irrigation. Industrial progress cause the spreading of polluted environment with toxic heavy metals causes many diseases such as lung cancer, allergic reaction , gastrointestinal, abnormalities of the skeletal system, kidney damage, prostate, skin rash, genetic material alteration, liver and kidney damage, weakened immune system , biochemical effects in humans, synthesis of haemoglobin etc. It has notice that some of the microbes showed resistivity towards the zinc and copper.

Bioremediation uses microorganisms to modify toxic pollutants and obtain energy for the production of biomass in the process. and biomass production. This kind of process is termed as bioremediation uses microorganisms for degradation of pollutants

Keywords: *Wastewater, Heavy Metals, Irrigation Water, Agricultural Practices, Microorganism, Food Pollutants, Bioremediation.*

INTRODUCTION

Crops irrigation is long term used practice which is very important for agriculture and horticulture irrigation of crops is an important and long-used practice to increase agricultural and horticultural production (1). 274 million hectares lands of agriculture were irrigated with the waste water which is about 16% of total earth area for cultivation (2). Irrigation is the main step in the crop production in areas with sporadic rainfall, which is why for food production million hectares areas are irrigated world-wide. Due to scarcity of irrigated water, wastewater is commonly used for irrigation which causes the risk of foodborne illnesses (3). Listeria spp., Salmonella spp. and verotoxin producing *Escherichia coli* are foodborne pathogens transferred through irrigation water to plant surfaces. Vero toxin-producing *Escherichia coli*, Salmonella spp. And Listeria spp. are some of the principal foodborne microorganisms, transfer from the irrigation water to plant surfaces (4, 5). Most of the foodborne pathogens are responsible for gastrointestinal diseases, although they are consumed freshly. Decontamination of irrigation water is highly recommended for hygienically safe agricultural production. Environment has great effect on pathogens and can survive for varying period depends on temperature, nutrient availability, humidity and UV radiation. Gastrointestinal diseases are allied with the fresh produce consumption, in which foodborne microorganisms are observed. For safe agriculture irrigation it is recommended, to use decontaminated water for irrigation, microorganisms can survive on plants surface for varying period of time, depends on the environmental conditions like nutrients, temperature, UV radiation and humidity (6).

The main objective of irrigation is to supply water to the soil, mainly to the vegetables, in order to prevent or remove deficiencies in soil moisture. However, irrigation water may also be applied to modify

the growth factors other than soil moisture deficiency in order to maintain or promote growth of crops (7). If water is expensive or if there is water shortage then frequent irrigation is a direct economic loss and even if water is inexpensive then excess application may adversely affect the crop growth by leaching soluble plant nutrients from the soil, which is harmful to the plant. Wastewater contaminated with heavy metals, microorganisms, organic pollutants, industrial wastes, factories waste products, inorganic compounds, etc (8). Marginal-quality water irrigation is a common practice adopted by millions of small-scale farmer around the world because they have no alternative (9). Irrigation water quality can be determined by the presence of salt in saline water used for the agriculture. Moreover crops are noticed by their ability to tolerate the salinity (10). Wastewater salinity used for irrigation is increased gradually, certain soil, cropping problems, water is increased and the only way to manage the salinity problem, salt through the rootzone is the only practice (11). Organic compounds contaminate the water with heavy metals, petroleum products, explosives, combustible and hazardous wastes (12, 13).

Biological function and different chemical properties of heavy metals elements make it harmful for irrigation. Heavy metals are termed as heavy metals due to those metals which have specific weights that are more than 5g cm-3. Among the heavy metals cadmium (Cd), arsenic (As), mercury (Hg) and Lead (Pb) are poison for humans because they are not easily digest due to which there is high risk for humans and also not easy to breakdown in environment. Cancer and gene transduction is also caused by these elements consumption. Biochemical reactions are activated by copper and zinc which serve as important constant in information of enzyme-substrate complex (14).

WASTEWATER AND IRRIGATION

Water available to farmer for irrigation has considerable impact on the type of plants. Water also affects the productivity of plants, water is the main source for the growth of plants therefore, it is important that water supply should be pure and natural for good health reason and to avoid the diseases. Healthy vegetation is only possible with clean water, good soil condition, water infiltration and healthy environmental condition, easily understood by analyzing in laboratory, it has been proved that the irrigation with waste water is considered to contribute the presence of heavy metals content in soil (15, 16). Heavy metals are abundant within the environment, due to the common and natural contamination by humans (17). The major cause of defilement of soil with overwhelming metals which is due to the expansive take-up of metals by nourishment crops that are developed on such damaged soil. Most commonly, wastewater contains considerable amounts of useful nutrients and toxic heavy metals, which are valuable but also causing major problems for agricultural. Heavy metals are accumulated in excess amount due to wastewater irrigation, cause soil contamination, and high uptake of these heavy metals by food crops which affect food quality (18). Heavy metals cause serious problems, aimed at human health, because these pollutantseasily enter into the body through the food chain and produce toxicity in the body through the food we eat. Aggregation of consuming metals in plants depends on the plants in retaining these overpowering metals through the soil either by take-up or soil to plant exchange variables of the metals. (19). Common heavy metals are (Cadmium (Cd), Chromium (Cr), Copper (Cu), Nickel (Ni), Lead (Pb) and Zinc (Zn) in wastewater. Wastewater are the main cause of high concentration of poisonous heavy metals sullies the soil , accumulates in excess amount in our body and excess of anything is poisonous for human health. Leaves of vegetable are mostly enrich with heavy metals and in most cases the edible portion of plants (20). Irrigation water is a water for the supplant precipitation within the generation of crops (21).

Deficiency of fresh water has forced the farmer to use any sort of water, counting wastewater, about 20 million hectares which is 7% of all inundated land are flooded with diverse sorts of squander water (22). The developed countries utilized wastewater, since developed countries contains sufficient sum supplements and is solid source of water supply (23).

IRRIGATION METHODS

Different water strategies are applied for agriculture. There are two primary sorts of water system strategies for irrigation called localized and surface irrigation (24). Surface irrigation is a straightforward

way of crop irrigation, in which water streams beneath gravity without pumping. Surface irrigation system performed as channel, border peel off irrigation or flood, water is not connected directly to the plant canopy, so the plant phylloshere cannot be sullied directly in case of contaminated water supply (25).

Localized system use water which is applied to each plant with the help of connected pipes (26). Localized irrigation method water can be supplied through spray or micro sprinkler in which water is supplied directly to the plant canopy, drip irrigation which applied water to the root zone of the each plant, or bubbler irrigation in which water is applied in low quantities to the soil adjacent (27).

Sub water system strategies can be utilized in a zones with high ground water level, in this type of irrigation water is upraised by pipes and pumps to underground channels and is made accessible through channel drive to the plant root sector (28).

Between the irrigation events microorganisms have been found within water remaining in channels. (29, 30). According to research in the USA on membrane bioreactor treatment Aeromonas, Legionella and other pathogens regrowth has been detailed (31). The flushing of the water system framework is must in arrange to diminish the chance of microorganisms defilement in channels. In Nigeria *E. coli,* Vibrio spp. and Salmonella spp were found from the irrigated plants. In open irrigation system aquatic plants and sediments helps the microorganisms to survive, whereas in piped based irrigation system microorganisms survive through biofilms. Survival of these microorganisms depend on few conditions like temperature, organic matter content, pH, radiation, competition with other microorganisms and supplements accessibility (32).

IRRIGATION WATER SOURCES

Earlier to use the irrigation water is put away in a source artificial, natural. About less than 1% of the Earths total water assets are fresh water, which is accessible for human and also used for irrigation (33). Some of the sources of water system are rainwater, groundwater, surface water and untreated wastewater. For the crop irrigation ground water is hygienically safer than surface water. Ground water is reachable through the wells and spring (34). For the crop irrigation various surface water can be utilized, surface water is eventually hydraulicly connected to groundwater, however become toxic with wastewater, agriculture run-off and stormwater, which in many cases contain loads of pathogens (35). For the crop irrigation rainwater is considered to be the easiest method (36). In man-made reservoirs rainwater harvesting is a term used for storing and collecting rainwater (37).

Ground water is basically used to irrigate the crops, and is used for managing the ground water for the guideline of using wastewater in agriculture and many other practices of life and microbial quality improvement the marginal water system at the farm level and a quantitative assessment of the risk of disease from the pathogenic microbes, present in surface water is basically identified when area that benefit for further investigation. Pathogens existing on food of animal origin, such as poultry, raw milk and meat are the main source of transmission of diseases caused by foodborne microbes which is very common and its awareness is growing that indicate that fresh processed fruits and vegetables are the main sources of causing pathogenic bacteria, viruses, helminths and protozoa (38).

Wastewater collected from the household sources without input from toilet or commode streams is known as greywater and 65 of total household is present in the grey water. Greywater from the household is recycled and it is reuse for irrigation and also for drinking in many region of the world (39).

WATER BORNE DISEASES

During the food processing plants and production on farms or watercourses, the food we eat are highly contaminated with polluted from the wastewater used for irrigation and the nature of pathogens and opportunities to transfer at any food chain cycle are the only reason of food borne disease (40). Disease transmission from food pathogens shows the potential of foodborne pathogens that are basically irrigated with the wastewater, mostly in fruits and vegetables. The ability of these microorganisms of causing major diseases in humans depends on the irrigated water and the amount of microorganisms excreted from this wastewater to cause disease in its dormancy period before it becomes infectious. They not only affect the humans but also the mammals (41).

IRRIGATION WATER HYGIENE

Irrigation water has hygiene quality assurance, by providing microbes free water before the plant absorption. Sanitization treatment incorporates warm treatment or pasteurization, UV radiation, filtration, ozonation and chlorination. Irrigation water can be purify through the organic methods that include physical or chemical process, each of the treatment possess some advantages and impediment whereas water purification through chlorine is one of the oldest method uses high oxidizing potential and inexpensive technique. Chlorine can be used in different forms, such as chlorine dioxide, chlorine gas and hypochlorite (42). Sedimented ponds, waste management, storage of waste and filtration through sand and soil, appear to diminish the levels of microbes in irrigation water (43, 44).

MICROORGANISMS AND AGRICULTURE

The main source of microorganisms in wastewater is human wastewater, ground- up scraps. In rural areas mostly onsite sewage facilities are used, most commonly septic systems, which include unicellular and multicellular organisms, brought by carriage waste to septic-system designs. Variety of microorganisms present in the soil which depend on organic materials in wastewater for nutrition, whereas bacteria, fungi, rotifers, nematodes, and protozoa, they all are found typically in septic system, more importantly aerobic bacteria are more affective at breaking down materials in wastewater, these types of bacteria only survive where oxygen is found. Soil is over-saturated with water therefore; it blocks the oxygen (45). Wastewater irrigated vegetables are commonly used in Quetta; irrigation with wastewater is one of main cause of diseases in our city. Microorganisms in the wastewater, are responsible of causing human illness, due to their presence in fresh fruits and vegetables (46). Tap water only reduce microbial load on raw fruits and vegetables and washing only removes soils and other debris from vegetables before cooking, but washing has no effect on microbes nor it can kill or removed them from vegetables we eat (47). During the irrigation a wide range of microorganisms have been found in water and are transferred to the crops (48).

The hone of sullied soil for the water system is considered to be responsible for the few flare- uos of maladies due to the utilization of such flooded crops (49). *E. coli* can survive for up to 300 days in autoclaved, filtered river water at 4 °C (50). Distinctive sorts of organisms have been found in several water system framework such as Salmonella, Listeria monocytogenes, Cryptosporidium oocysts. Favorable conditions for the microorganisms survival in a water circuit are sediment accumulation, microbial interactions, protection from UV light and good nutrient availability (51).

MICROORGANISM IN SALAD/RAW VEGETABLES AND FOOD BORNE DISEASES

Salads support the growth of foodborne pathogens and bacterial diseases under favorable conditions like moisture food, nutrients that support the growth of bacteria under favorable conditions, bacteria are easily multiply when provided a favorable temperature for the bacteria and contaminates the food usually near the optimal temperature of the organisms for their growth and after certain time these organism produces their toxins cause the sickness in those whose devour the sullied nourishment (52).

Microorganisms have been listed in the table that are presents in the vegetables different parts, mention in the below (Table I).

MICROORGANISMS IN SEWAGE

Sewage water contains pathogens isolated from various investigations which are same pathogens present in the animal's wastes. The animals waste has the potentialities of transmission of human disease and parasitic infection through the soil, when these wastes are provided for agricultural practices. The soil fertilization with the human waste were very common in the past decades due to which it becomes a common practice till now and unnamed diseases took birth in the society (63).

HEAVY METALS POLLUTION

Industrialization causes natural contamination with overwhelming metals which is increasing day by day (64). Heavy metals are heterogeneous elements of periodic table group,, arranged according to element chemical properties and its natural functions. Heavy metals are those metals which have specific weights more than 5g cm-3 (65), produces toxins in human and food, among them (As) arsenic, (Hg) mercury, (Pb) lead and (Cd) cadmium are growing poison, accumulating in food chain through the primary producer levels uptake, in human body enters through injection or inhalation. These metals are carcinogenic and mutagenic (66).

Table I. Microorganisms that contaminate vegetables

Microorganisms	Vegetables	Source of contamination	References
Salmonella typhi	Leaf tips	Polluted soil	(53), (54)
	Radishes	Polluted soil	
	Lettuce	Polluted soil	(55)
Salmonella *(other types)*	Celery	Water system for irrigation	(56), (57)
	Vegetables	Water systems usage for irrigation	
	Green onions	Water systems for irrigation	
Enteroviruses	Vegetables	Irrigation water	(58)
Ascaris ova	Lettuce	Irrigation water	(59)
	Cabbage	Irrigation water	
Helminth ova	Vegetables	Irrigation water	(60)
	Cucumbers	Irrigation water	
	Tomatoes	Irrigation water	
	Carrots.	Irrigation water	
L. monocytogenes	Cucumber, cabbage, radishes, potatoes.	Irrigation water	(61)
Total coliform	Spinach, ridge guard, cucumber, lady finger.	Irrigation water	(62)
Staphylococcus aureus	Ridge guard, cucumber, ladyfinger, spinach.	Irrigated water	(62)

Cadmium, lead, nickel, mercury, chromium, cadmium, arsenic, copper, manganese, iron, zinc are known as the trace elements, known as environmental pollutants in places with high anthropogenic weight, copper, manganese, zinc, and iron also known as important trace micronutrients. All organisms are seriously affected by trace heavy metals presents in the atmosphere, water, soil and abundant bioavailability of these heavy metals can result in bioaccumulation in the food chain proved to be very toxin for human. Heavy metals contaminate the soil, ground water, wastewater, surface water, sediments particulate vegetables causing serious health problems. Although human body needs trace elements in a low quantity to fulfill the body requirements such as vitamins and minerals (67). Trace elements plays an important role in biological, chemical, metabolic biochemical, enzymatic reactions and catabolic reaction in the living cells of human, animals and plants. human body contains these trace elements in a broad concentration to fulfil body requirements. Heavy metals are often called as xenobiotic as they are not that much beneficial for our body functioning but they are harmful when present in a minor concentration in body (68).

First discovered in 1992, by environmental protection agency (EPA) about the effects of trace elements on crops due to wastewater irrigation. The reuse of wastewater by industries and in agricultural practices were studied in 2004 which also include new information on treatment, emerging chemicals,

pathogens of concern, disinfection technologies, user rate, and funding alternatives, sources of information, acceptance, research activities and public involvement (69). Intake of contaminated water causes accumulation of large number of chemicals in the body. These chemicals may range from sodium fluoride (an active ingredient in rat poison), aluminum and chlorine to some heavy metals like nickel, chromium, lead and cadmium. All are harmful in our bloodstream beyond some tolerable limitations. Lead, cadmium in water is toxic for our body (70).

Table II. Heavy metals that affect human health

#	Heavy metals	Health affects	References
1	**Cadmium**	Gastrointestinal, lungs irritation. Abnormalities of the skeletal system, kidney damage, prostate and lung cancer	(71)
2	**Chromium**	Allergic reaction, skin rash ,nose irritations, genetic material alteration, liver and kidney damage, weakened immune system and cancer	(72, 73)
3	**Lead**	Biochemical effects in humans, synthesis of haemoglobin. Reaction on kidneys, teeth, bone, gastrointestinal tract and regenerative system. Damage the anxious framework.	(74, 75)
4	**Nickel**	Skin irritation, hypersensitivity. Lung Fibrosis, kidney and cardiovascular diseases, respiratory tract cancer, contact dermatitis allergy.	(76)
5	**Mercury**	Produces toxic in the environment in substantial quantities through natural events.	(77)
6	**Arsenic**	Acute toxic effects include hyperesthesia in extremities, abdominal cramping, abdominal electrocardiogram and abdominal patellar reflexes.	(78)
7	**Mercury**	Loss of memory, fatigue and concentration, tremors constriction of visual field cortical blindness.	(79)
8	**Zinc**	Excess intake causes the production of Metallothionein production, controls the oxidative stress.	(81, 82)
9	**Iron**	Excess intake causes, cancer, poisoning in children due to overdose, stomach, nausea, and vomiting.	(83)
10	**Selenium**	Gastrointestinal disturbances, hepatotoxicity, impairment of natural killer cells, disturb endocrine function.	(84)
11	**Barium**	Respiratory failure, gastrointestinal dysfunction, cardiac arrhythmias and elevated blood.	(85)
12	**Silver**	Lungs and throat irritation, stomach pain, breathing problems, skin and other body tissues turn blue-gray or gray	(86)

HEAVY METALS IN MICROBES

Pseudomonas species is resistant towards the cadmium (87) whereas Acinetobacter species is highly resistant towards nickel (88). Identified bacteria are used to remediate heavy metal contaminated wastewater and sewage water (89).

Table III. Microbe's resistivity against metals

	Bacteria	Resistant	MIC
1	Staphylococcus spp.	Chromium	500 µg/ml
2	Escherichia coli	Chromium	200 µg/ml
3	Klebsiella spp.	Chromium	150 µg/ml
4	Flavobacterium spp.	Cadmium	300 µg/ml
5	Bacillus spp.	Nickel	200 µg/ml
6	Staphylococcus	Nickel	150 µg/ml
7	Pseudomonas spp.	Copper	300 µg/ml
8	Methyl bacterium	Cobalt	250 µg/ml
9	Acinetobacter spp.	Cadmium	150 µg/ml
10	Citrobacter spp.	Cadmium	220 µg/ml

*Source of data: Rajbanshi A. 2008 (90)

HEAVY METALS AND DISEASES

Copper know as trace elements and its excessive intake cause stomach torment, postpartum, liver harm (91) certain overwhelming metals such as Zn, Cu, or Mn interferes with Fe metabolism and cause physiological changes, that resembles to Fe deficiency syndrome (91). Lead causes cumulative effect on human, put away in body parts, particularly in greasy tissue and teeth proved to be toxic for body (92). Wide-ranging population exposure to arsenic is mainly via intake of drinking water and food. In few zones arsenic in drinking water is the most presentation for inorganic arsenic and methylated in people, and the metabolites are excreted in pee (93). Most abundant element in the earth detected from distinctive media in all parts of the biosphere, classified as the borderline metal particle for having both delicate and difficult metal properties, bind to sulfur, oxygen and nitrogen groups (94). Nickel within the drinking water is leaching from metals in contact with drinking water, such as channels, moreover show in a few ground water as results of disintegration from nickel bearing rocks (95). Cadmium reported, as a heavy metal posing severe risk to human health (96) and has not been appeared to have any physiological work inside the, human body (97). Diet intake of about 300 gm/day causes gastrointestinal disturbances, affects endocrine function, hepatotoxicity and responsible for impairment of natural killer cells (98). Barium is responsible to cause respiratory failure, gastrointestinal dysfunction, elevated blood pressure and cardiac arrhythmias (99). Breathing issue, lungs and throat disturbance, stomach pain is very common case, when silver is exposed. Also causes skin and other body tissues to turn gray or blue-gray (100). Present in the food due the wastewater irrigation ,causes hair damaged, insomnia, temper outburst, brain damage, lung and kidney failure, autoimmune diseases, depression, drowsiness and fatigue (101, 102).Fatigue, dizziness is cause due to the excess intake of zinc (103). Cough, shortness of breath, runny nose, nose ulcers, wheezing, breathing issue such as asthma and hair damaged. Damages lungs, fragile bones, affect calcium regulation in natural systems, endocrine disruptor, mutagenic, and carcinogenic (104).

BIOREMEDIATION

Ability of certain microorganisms to convert, utilize and modify toxic pollutants in order to obtain energy and biomass production in the process. This kind of process is termed as bioremediation in which the microorganisms is used for the biodegradation of pollutants. Microorganisms are widely distributed on the biosphere because of their metabolic ability and can easily grow in a wide range of environmental conditions (105). Bacteria, fungi and archaea are typical prime bioremediators used for bioremediation in order to clean up contaminated sites (106). Microorganisms act as important pollutants removal tools in water, sediments and soil, that is due to their advantage over other remediation hone conventions. Microorganism are preventing the further pollution and restoring the original surroundings (107). A technique that involves use of organisms to neutralize pollutants from a contaminated site. Environmental protection agency (EPA) defines that bioremediation is technically a wastewater management, use naturally occurring organisms to break down hazardous substances to less toxic substances (108). Chemical contaminants and microorganisms are used as an energy source using their metabolic process during the microbiological process (109). Hazardous pollutants which when released into the natural water bodies, they cause serious environmental degradation and also increases the human health risk, which is largely due to heavy metals, chloride, high dissolved salt, toxic chemicals and other pollutants (110). Bioremediation only effectively occur through the addition of oxygen, fertilizers, to encourage the microorganisms growth for the degradation of pollutants within bio-stimulation (111). Bioremediation depends on many conditions such as the physiochemical characteristics of the environment, their accessibility to microorganisms, concentration of pollutants and the chemical nature of pollutants (112). Recent discoveries have been proved to be successful by the expansion of coordinated strains of microorganisms to the medium in order to enhance the microorganisms' populace capacity ability to degenerate (113, 114).

CONCLUSION

Result based conclusion are as follows. The general overview of this research work is based on water borne diseases related to wastewater irrigation. Due to the shortage of irrigation water in agriculture practices wastewater are commonly used for irrigation of vegetables. The lack of awareness people buy vegetables without knowing the origin of irrigation area, that from where these vegetables are process, brought and which source of water are used for irrigation, due to which most of the people in our society are affected with diseases such as diarrhea, abdominal cramping, fatigue, cancer and abdominal patellar reflexes. In future these kind of problems will be increased because of the increased population and shortage of healthy water causing unhealthy crop production. Squander treatment unit ought to be introducing at the conclusion of the water supply system, using photocatalysis if there is a tall load of organisms within the water system. Low water content for cultivation of vegetables did kill human pathogens from the phyllosphere. In future more research work on wastewater management is required to reduce the risk of microorganisms population on crops. Photocatalysis unit may be required within the water system water dissemination framework. Agricultural practices must be used which improves the developments of antioxidants such as phenolic compounds and should adopt the hone that reestablish the development of competing bacteria to decrease the numbers of enteric pathogens within the plant phyllosphere. Special measures are required to improve the quality and hygiene of food items.

References:

1. FAO Water at a glance, The relationship between water, agriculture, food security and poverty. Food and Agriculture Organization. 2010.
2. Miraglia M, Marvin HJP, Kleter GA, Battilani P, Brera C, Coni E, Cubadda F, Croci L, De Santis B, Dekkers S, Filippi L, Hutjes RWA, Noordam MY, Pisante M, Piva G, Prandini A, Toti L, Van den Born GJ, Vespermann, A. Climate change and food 59 safety: An emerging issue with special focus on Europe. Food and Chemical Toxicology. 2009**;** 47**:**1009-1021.
3. Liu C, Hofstra N, Franz E**.** Impacts of climate change on the microbial safety of pre-harvest leafy green vegetables as indicated by Escherichia coli O157 and Salmonella spp. International journal of food microbiology 2013;163:119-128.
4. Beuchat LR**.** Pathogenic microorganisms associated with fresh produce. Journal of food protection 1996; 59:204-216.
5. Brand MT. Fitness of human enteric pathogens on plants and implications for food safety. Annual Review of Phytopathology. 2006;44:367-392.
6. Chavan PD, Karadge BA**.** Influence of salinity on mineral nutrition of peanut (Arachis hypogea L.). Plant and Soil. 1980;54: 5-13.
7. Connor U, Connor UM, Long MH. Contrastive rhetoric: Cross-cultural aspects of second language writing. Cambridge University Press; 1996 Jan 26.
8. Qadir M., Wichelns D, Raschid-Sally L, Minhas PS, Drechsel P, Bahri A, Ensink JH. Agricultural use of marginal-quality water: Opportunities and challenges. **.** 2007; 612:2016-40578.
9. Maas EV, Grattan SR. Crop yields as affected by salinity. Agronomy. 1999;38:55-110.
10. Ayers RS, Westcot DW. Water quality for agriculture. Rome: Food and Agriculture Organization of the United Nations. 1985;29.
11. Zobel RW, Kinraide TB, Baligar VC. Fine root diameters can change in response to changes in nutrient concentrations. Plant and Soil. 2007;297(1):243-54.
12. Zheljazkov V, Jekov D. Heavy metal content in some essential oils and plant extracts. In International Symposium on Medicinal and Aromatic Plants 426 1995;27: 427-434.
13. Mildvan, A. S. 9 Metals in Enzyme Catalysis. Academic Press. In The enzymes. 1970; 2: 445-536.
14. Mapanda F, Mangwayana EN, Nyamangara J, Giller KE. The effect of long-term irrigation using wastewater on heavy metal contents of soils under vegetables in Harare, Zimbabwe. Agriculture, Ecosystems & Environment. 2005;107:151-165.
15. Nan Z, Li J, Zhang J, Cheng G. Cadmium and zinc interactions and their transfer in soil-crop system under actual field conditions. Science of the Total Environment. 2002;285(1-3):187-95.
16. Wilson B, Pyatt FB. Heavy metal dispersion, persistance, and bioccumulation around an ancient copper mine situated in Anglesey, UK. Ecotoxicology and environmental safety. 2007;66(2):224-31.

17. Muchuweti M, Birkett JW, Chinyanga E, Zvauya R, Scrimshaw MD, Lester JN. Heavy metal content of vegetables irrigated with mixtures of wastewater and sewage sludge in Zimbabwe: implications for human health. Agriculture, Ecosystems & Environment. 2006;112(1):41-8.
18. Rattan RK, Datta SP, Chhonkar PK, Suribabu K, Singh AK. Long-term impact of irrigation with sewage effluents on heavy metal content in soils, crops and groundwater—a case study. Agriculture, ecosystems & environment. 2005;109(3-4):310-22.
19. Khan S, Cao Q, Zheng YM, Huang YZ, Zhu YG. Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China. Environmental pollution. 2008;152(3):686-92.
20. Hargreaves GH, Merkley GP. Irrigation Fundamentals: an applied technology text for teaching irrigation at the intermediate level. Water Resources Publication; 1998.
21. Scott CA, Faruqui NI, Raschid-Sally L, editors. Wastewater use in irrigated agriculture: Confronting the livelihood and environmental realities. CABI; 2004 Jun 25.
22. Hussain I, Raschid L, Hanjra MA, Marikar F, van der Hoek W. A framework for analyzing socioeconomic, health and environmental impacts of wastewater use in agriculture in developing countries. IWMI; 2001.
23. Cuenca RH. Irrigation system design. An engineering approach. Prentice Hall; 1989.
24. Das AP, Singh S. Occupational health assessment of chromite toxicity among Indian miners. Indian journal of occupational and environmental medicine. 2011;15(1):6.
25. Solomon EB, Potenski CJ, Matthews KR. Effect of irrigation method on transmission to and persistence of Escherichia coli O157: H7 on lettuce. Journal of food protection. 2002;65(4):673-6.
26. Ramalan AA, Nega H, Oyebode MA. Effect of deficit irrigation and mulch on water use and yield of drip irrigated onions. WIT Transactions on Ecology and the Environment. 2010;134:39-50.
27. Frenken K, editor. Irrigation in Africa in figures: AQUASTAT survey, 2005. Food & Agriculture Org.; 2005.
28. Albregts EE,Clark GA Stanley CD, Zazueta FS, Smajstrla AG. Preplant fertilization of fruiting micro irrigated strawberry. Hortscience 1991;26(9):117-7
29. Vanderlinden K, VereekenH,Hardelauf H,Herbst M, Martinex G, Cosh MH, Pachepsky YA. Temporal stability of soil water contents: A review of data and analyses. Vadose Zone Journal. 2012;11(4).
30. Juhna T, Birzniece D, Larsson S, Zulenkovs D, Sharipo A, Azevedo NF, Menard-Szczebara F, Castagnet S, Feliers C, Keevil CW. Detection of Escherichia coli in biofilms from pipe samples and coupons in drinking water distribution networks. Applied and environmental microbiology. 2007;73(22):7456-64.
31. Jjemba PK, Weinrich LA, Cheng W, Giraldo E, LeChevallier MW. Regrowth of potential opportunistic pathogens and algae in reclaimed-water distribution systems. Applied and environmental microbiology. 2010;76(13):4169-78.
32. Pachepsky Y, Shelton DR, McLain JE, Patel J, Mandrell RE. Irrigation waters as a source of pathogenic microorganisms in produce: a review. Advances in agronomy. 2011;113:75-141.
33. Zia H, Harris NR, Merrett GV,Rivers M, Coles N. The impact of agriculture activities on water quality: A case for collaborative catchment management using integrated wireless sensor networks. Computers and electronics in agriculture. 2013;96:126-38.
34. Ayers RS, Westcot DW. Water quality for agriculture. Rome: Food and Agriculture Organization of the United Nations;1985.
35. Winter, T.C. Ground water and surface water: a single resource: Diane Publishing;1999.
36. Li cook S, Geballe GT, Burch Jr WR. Rainwater harvesting agriculture: an integrated system for water management on rainfed land in China's semiarid areas. AMBIO: A Journal of the Human Environment.2000;29(8):477-83.
37. Mayouf JA. Determination of Iron, Copper, Lead and Casmium Concen-tration in Rain Water Tanks in Misurata. Libya. International Journal of Physical Science. 2012;2(5):112-8
38. Steele M, Odumeru J. Irrigation water source of foodborne pathogens on fruit and vegetables. Journal of food protection. 2004;67(12):2839-49.
39. Zhao L, Zhang F, Ding X, Wu,G, Lam YY, Wang X, Fu H, Xue X,Lu C, Ma J,Yu L. Gut bacteria selectively promoted by dietary fibers alleviate type 2 diabetes. Science .2018;359(6380):1151-6.
40. Mansell A, Bryan C, Levison H. Airway closure in children. Journal of Applied Physiology. 1972;33(60:711-4.
41. Feachem RG, Bradley DJ, Garelick H, Mare DD. Sanitation and health aspects of excreta and wastewater management. Published for the World Bank by Willey; 1983.

42. Newman, S.E. Disinfecting irrigation water for disease management. Proceeding of 20th Annual conference on pest management on Oma mentals, Society of American Florists, San Jose, CA 2004;2-10.
43. Abaidoo RC, Keraita B, Drechsel P, Dissanayake P, Maxwell AS. Soil and crop contamination through wastewater irrigation and options for risk reduction in developing countries. InSoil biology and agriculture in the tropics 2010 (pp. 275-297). Springer, Berlin, Heidelberg.
44. Mara DD, Silva SA. Removal of intestinal nematode eggs in tropical waste stabilization ponds. The Journal of tropical Medicine and Hygiene. 1986;89(2):71-4.
45. Tomask B. Th importance of wild -animals suffering. Relations. Beyond Anthropocentrism. 2015;3(2):133-52.
46. Koch CA, Mazzaferri, EL. Larry JA, Fanning TS. Bulloud pemphigoid after treatment with furosemide Cutis. 1996;58(5):340-4.
47. Beuchat LR, Nail BV, Adler BB, Clavero MRS. Efficacy of spray application of chlorinated water in killing pathogen bacteria on raw apples, tomatoes and lettuce. Journal of food protection. 1998;61:1305-11.
48. Okafo CN, Umoh VJ, Galadima M. Occurrence of pathogens on vegetables harvested from soil irrigated with contaminated streams. Science of The Total Enironment. 2003;311:49-56.
49. Beuchat LR and Ryun JH. Produce handling and processing practices. Emerging infectious diseases.1997;3:459.
50. Flint KP. The long-term survival of Escherichia coli in river water. Journal of Applied Bacteriology. 1987;63(3):261-70.
51. Pachepsky Y, Morrow J, Guber A, Shelton D, Rowland R, Davies G. Effect of biofilm in irrigation pipes on microbial quality of irrigation water. Letters in applied microbiology. 2012;54(3):217-24.
52. Bryan H. Leisure value system and recreational specialization: The case of trout fisherman. Journal of leisure research.1977;9(3):174-87.
53. Creel RH. Vegetables as a possible factor in the dissemination of typhoid fever. Treasury Department, Public Health and Marine-Hospital Service of the United States;1912.
54. Balaser MJ ,Newman LS. A review of human salmonellosis: I. Infective dose. Review of infectious diseases. 1982;4(6):1096-106.
55. Wang WL, Dunlop SG, Munson PS. Survival of Shigella in Sewage: II. Effect of Glycerol on Shigella flexneri and Shigella Bacteriophage. Applied Microbiology. 1964;12(3):188-94.
56. William FA. Spray combustion and atomization. The physics of fluids. 1958;(6):541-5.
57. Edwin EE, Jackmsn R. Thiaminase I in the development of cerebrocortical necrosis in sheep and cattle. Nature. 1970;228 (5273):772-4.
58. Larkin JH. Enriching formal knowledge: A model for learning to solve textbook physics problems. Cognitive skills and their acquisition.1981:311-34
59. Wang WL, Dunlop SG. Animal parasites in sewage and irrigation water. Sewage and Industrial Wastes.1954:1020-32.
60. Dudlova A, JurisP, Jarcuska P, Vasikova Z, Vargova V, Sumkova M, Krcmery V. The incidence of pinworm (Enterobius Vermicularis) in pre-school and school aged children in the eastern Slovakia. Helminthologia.2018;55(4):275.
61. Heisick JE, Wagner DE, Nieman ML, Peeler JT. Listeria spp. found on fresh market produce. Applied and Environmental Microbiology. 1989;55(8):1925-7.
62. Creatore MI, Glazieer RH, Moineddin R, Fazli GS,Johns A, Gozdyra P, Matheson FI, Kaufman-Shiriqui V, Rosella LC, Manuel DG, Booth GL. Association of neighborhood walkability with change in overweigh, obesity, and diabetes. Jama 2016;(20):2211-20.
63. Rudolf PO. Forest plantations in the Lake States. US Department of Agriculture;1950.
64. Mythili K Karthikeyan B. Bioremediation of chromium [Cr (VI)] in tannery effluent using Bacillus spp. and staphylococcus spp. Int J Pharm Biol Arch. 2011;2(5):1460-3.
65. Raikwar MK, Kumar P, Singh M, Singh A. Toxic effect of heavy metals in livestock health. Veterinary world. 2008;1(1):28.
66. Mildvan AS. 9 Metals in enzyme Catalsis. In The enzymes. 1970;2:445-536. Academic Press.
67. Paris I, Jones Jr JB. The handbook of trace elements. Crc PRESS; 1997.
68. Waseem A, Arshad J, Iqbal F, Sajjad A, Mehmood Z, Murtaza G. Pollution status of Pakistan: a retrospective review on heavy metals contamination of water, soil, and vegetables. BioMed research international. 2014.

69. Jaramillo MF, Retrepo I. Wastewater reuse in agriculture: A review about its limitations and benefits. Sustainability. 2017(10):1734.
70. Rosell R, Molina MA, Costa C, Simonetti S, Gimenez-Capitan A, Bertran-Alamillo J, Mayo C, Moran T, Mendez P, Cardenal F, Isla D. Pretreatment EGFR T790M mutation and BRCA1 mRNA expression in erlotinib-treated advance non-small-cell lung cancer patients with EGFR mutstions. Clinical Cancer Research. 2011;17(5):1160-8.
71. Bernard A. Cadmium & its adverse effects on human health. Indian Journal of Medical Research. 2008;128(3):557.
72. Bielicka A, Bojanowska I, Wisniewski A. Two face of Chromium-Pollutant and Bioelement. Polish Journal of environmental studies.2005;14(1).
73. Singh V , Joung D, Zhai L, Das S, Khodaker SI, Seal S. Graphene based materials: past , present and future. Progress in materials science. 2011;56(8):1178-271.
74. Wennberg M,Bergdahl, IA,Stegmayr B, Hallmans G, Lundh, T, Skerfying S, Stromberg U, Vessby B, Jansson JH. Fish intake , mercury, long-chain n-3 polyunsaturated fatty acids and risk of strok in northern Sweden. British Journal of Nutrition. 2007;98(5):1038-45.
75. Tracy CM, Epstein AE, Darbar D, DiMarco JP, Dunbar AB, Estes NM, Ferguson TB, Hammil SC, Karasik PK,Link MS, Marine JE. 2012 ACCF/AHAHRS focused update of the 2008 guidelines for device-based therapy of cardiac rhythm abnormalities: a report of the American College of Cardiology Foundation/American College of Cardiology. 2012;60(14):1297-313.
76. Thenkabail PS, Mariotto I, Gumma MK, Middleton EM, Landis DR, Huemmrich KF. Selection of hyperspectral narrow bands(HNBs) and composition of hyperspectral of two bands vegetation indices (HIVs) for biophysical characterization and discrimination of crops types using field reflectance and Hyperion/EO-1 data. IEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. 2013;6(2):427-39
77. Kiyono M, Pan-Hou H. Genetic engineering of bacteria for environmental remediation of mercury. Journal of Health Science. 2006;52(3):199-204
78. Franzblau A, Lilis R. Acute arsenic intoxication from environmental arsenic exposure. Archives of Environmental Health: An International Journal. 1989;44(6):385-90.
79. Jarup L, Hazards of heavy metals contamination. British medical bulletin. 2003;68(1):167-82
80. Richards MP, Cousins RJ. Mammalian zinc homeostasis: requirement for RNA and metallothionein synthesis. Biochemical and biophysical research communications. 1975;64(4):1215-23.
81. Cousins RJ. Absorption, transport, and heptic metabolism of copper and zinc: special reference to metallothionein and ceruloplasmin. Physiological review. 1985;65(2):238-309.
82. Kaunang TA, Kapantow NH, Langi FL. Gambaran Asupan Vitamin Larut Air pada Tenage Pedidik dan kependidikean FKM. Unsrat Saat Pembatasan Sosial Masa Pandemic COVID-19.KESMAS. 2020;9(7).
83. Vinceti M, Wei ET, Malagolo C, Bergomi M, Vivoli G. Adverse health effects of selemium in humans. Reviews on environmental health. 2001;16(4):233-52.
84. Jacobs JE, Lanza S, Osgood DW,Eccles JS,Wigfield A. changes in children's self-competence and values: Gender and domain differences across grades one through twelve. Child delelopment. 2002; 73(2):509-27.
85. Hall AH. Chronic arsenic poisoning. Toxocology letters. 20021;128(1-3):69-72.
86. Filali BK, Taoufik J, Zeroual YF, Dzairi FZ, Talbi M, Blaghen M. Waste water bacterial isolates resistant to heavy metals and antibiotics. Current microbiology. 2000;41(3):151-6.
87. Arber N, Eagle CJ, Spicak J, Racz I, Dite P, Haier J, Zavoral M, Lechuga MJ, Gerletti P, TangJ, Rosenstein RB. Celecoxib for the prevention of colorectal adenomatous polyps. New England Journal of Medicine. 2006; 355(9)//;885-95.
88. Nicol JW, Helt GA, Blanchard Jr SG, Raja A, Loraine AE. The Integrated Genome Browser: fress software for distribution and exploration of genome-scale datasets. Bioinformatics. 2009;25(20):2730-1.
89. Rajbanshi A. Study on heavy metals resistant bacteria in Guheswori sewage treatment plant. Our nature. 2008;6(1):52-7.
90. Cherop C, Keverenge-Ettyang A, Mbagaya GM. Barriers to exclusive breastfeeding among infants aged 0-6 months in Eldoret municipality, Kenya. East Africa journal of public health. 2000;6(1).
91. Gweyi-Onyango JP, Osei-Kwarteng M. Safe vegetable production with wastewater in developing countries: demystifying the negative notions. African Journal of Horticultural Science. 2011;5.

92. Budd P, Montgomery J,Cox A, Krause P, Barreiro B, Thomas RG.The distribution of lead within ancient and modern human teeth: implications for long term and historical exposure monitoring. Science of the Total Environment. 1998;220(2-3):121-36.
93. Jarup L. Hazards of heavy metals contamination. British medical bulletin. 2003;68(1):167-82.
94. Costa M, Klein CB. Nickel carcinogenesis, mutation, epigenetics, or selection. Environmental Health Perspectives. 1999;107(9):A438-9.
95. Poonkothai MV, Vijayathi BS. Nickel as an essential element and a toxicant. International Journal of Environmental Sciences. 2012;1(4):285-8.
96. Winblad B, Palmer K, Kivivpelto M, Jelic V, Fratiglioni L, Wahlund LO, Norberg A, Backman L, Albert M, Almkvist O, Arai H. Mild cognitive impairment-beyond controversied, towards a consensus: report of the International Working Group on Mild Cognitive, Impairment Journal of internal medicine.2004;256(3):240-6.
97. Gorrn P, Sander M, Meyer J, Kroger M, Becker E, Johannes HH, Kowalsky W, Riedl T. Towards see-through displays: fully transparent thin-film transistors driving transparent organic light-emitting diodes. Advances materials. 2006; 18(6):738-41.
98. Viceti M, Wei ET, Malagoli C, Bergomi M, Vivoli G. Adverse health effects of selenium in humans. Reviews on environmental health. 2001;16(4):233-52.
99. Vinceti M, Wei ET, Malagoli C, Bergomi M, Vivoli G. Adverse health effects of selenium in humans. Reviews on environmental health. 2001;16(4):233-52.
100. Jacobs JE, Lanza Osgood DW,Eccles JS, Wigfield A. Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. Child development. 2002;73(2):509-27.
101. ATSDR. Toxicological profile for silve Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Service, Public Health Service, Atlanta, GA, USA.
102. Balady GJ M ,Gulati M, Keteyian SJ. Clinician's guide to cardiopulmonary exercise testing in adults: a scientific statement from the American Health Association Circulation. 2010;122(2):191-225.
103. Pieczenik SR, Neustadt J. Mitochondrial dysfunction and molecular pathways of disease. Experimental and molecular pathology. 2007;83(1):84-92.
104. Dummer R, Kamarashey J, Kempf W, Haffiner AC, Hess-Schmid M, Burg G. Junctional CD+ cutaneous lymphomas with nonaggressive clinical behavior: a CD+ variant of mycosis fungoides. Archives of dermatology. 2002;138(2):199-203.
105. Salem HS, Chilingarian GV. Influence of porosity and direction of flow on tortuosity in unconsolidated porous media. Energy Sources. 2000; 22(3):207-13.
106. Tang JW, Lai FY , Nymadawa P, Deng YM, Ratnamohan M, Loh TP, Tee NW, Dwyer DE, Barr IG, Wong FY. Comparison of the incidence of inflnuza in relation to climate factors during 2000-2007 in five countries. Journal of medical virology. 2010;82(11):1958-65.
107. Strong C, Magnusdottir G. Tropospheric Rossby wave breaking and the NAO/NAM. Journal of the atmospheric sciences. 2008;65(9):2861-76.
108. Demnerova K, Mackova M, Spevakova V, Beranova K, Kochankova L, Lovecka P, Ryslava E, Macek T. Two approaches to biological decontamination of groundwater and soil polluted by aromatics-characterization of microbial populations. International Microbiology. 2005;8(3):205-11.
109. Asplin BR, Magid DJ, Rhodes KV, Solberg LI, Lurie N, Camargo Jr CA. A conceptual model of emergency department crowding. Annals of emergency medicine. 2003;42(2):173-80.
110. Ahirwar R, Nahar S, Aggarwal S, Ramachandran S, Maiti S, Nahar P. In silico selection of an aptamer to estrogen receptor alphe using computational docking employing estrogen response elements as aptamer-alike molecules. Scientific reports. 2016;6(1):1-1.
111. Sujatha S, Prahari I. Glycopeptide resistance in gram- positive cocci: a review. Interdisciplinary perspectives on infectious diseases. 2012;2012.
112. Mann JJ, Malone KM, Sweeney JA, Brown RP, Linnoila M, Stanley B, Stanley M. Attempted suicide characteristics and cerebrospinal fluid amine metabolites in depressed in patients. Neuropsychopharmacology. 1996;15(6):576-86.
113. EI Fantroussi S, Agathos SN. Is bioaugmentation a feasible strategy for pollutant removal and site remediation. Current opinion in microbiology. 2005;8(3):268-75.
114. Castillo-Carvajal LC, Sanz-Martin JL, Barragan-Huerta BE. Biodegradation of organic pollutants in saline wastewater by halophilic microorganisms: a review. Environmental Science and Pollution Research. 2014;21(16):9578-88.