

ADDITIONAL MATERIAL TO GE2202

CH 8: ETHICS OF TECHNOLOGY

What is meant by technological ethics?

Technology ethics is the application of ethical thinking to the practical concerns of technology. The reason technology ethics is growing in prominence is that new technologies give us more power to act, which means that we have to make choices we didn't have to make before.

Most Important Ethical Issues in Technology

Misuse of Personal Information, Misinformation and Deep Fakes, Lack of Oversight and Acceptance of Responsibility, Use of AI, Autonomous Technology, Respect for Employees and Customers, Moral Use of Data and Resources, Responsible Adoption of Disruptive Tech.

The Pros and Cons of Technology

Pros: 1) improve efficiency, 2) saves time, 3) better communication, 4) reduces cybercrime risks

Cons: 1) extreme dependability, 2) expensive, 3) shortage of jobs, 3) malfunctions

How technology is affecting the human values?

As scientific advances improve our lives, they also complicate how we live and react to the new technologies. More and more, human values come into conflict with scientific advancement as we deal with important issues such as nuclear power, environmental degradation and information technology.

What are the impact of social media to our daily lives?

Emotion. Multiple studies have shown that unlimited use of social media causes stress, bad moods and negative mental health. Many people wake up in the morning and immediately check their Instagram, Snapchat or Twitter.

Is technology good or bad for us?

While some forms of technology may have made positive changes in the world, there is evidence for the negative effects of technology and its overuse, as well. Social media and mobile devices may lead to psychological and physical issues, such as eyestrain and difficulty focusing on important tasks.

Nanotechnology

It is the branch of technology that deals with structures that are less than 100 nanometres long. Scientists often build these structures using individual molecules of substances. Nanotechnology will enable engineers to construct sophisticated nanorobots that can navigate the human body.

What are the social implications of nanotechnology to people?

Nanotechnology will have significant social impacts in the areas of military applications, intellectual property issues, as well as having an effect on labor and the balance between citizens and governments.

What are the benefits and the negative impacts of nanotechnology?

Hazards and risks of nanoparticles include increased production of ROS, DNA damage, genotoxic effects, damages to organs and tissues in humans, effects on growth and yield of crop plants and negative impacts on beneficial bacteria in the environment.

Nanotechnology is helping to considerably improve, even revolutionize, many technology and industry sectors: information technology, homeland security, medicine, transportation, energy, food safety, and environmental science. Despite many benefits of nanotechnology there are potential risks and ethical issues involved in its implementation. There is a concern that some nanoparticles could be toxic because elements at the nanoscale behave differently than they do in their bulk form and these particles could easily cross the blood-brain barrier.

MACHINE ETHICS

What do you mean by machine in ethics?

Machine ethics (or machine morality, computational morality, or computational ethics) is a part of the ethics of artificial intelligence concerned with adding or ensuring moral behaviors of man-made machines that use artificial intelligence, otherwise known as artificial intelligent agents.

Should AI be guided by ethics?

AI ethics and safety must be a priority in the design and implementation of AI systems. AI Ethics emerges to avoid individual and societal harms caused by the misuse, abuse, poor design, or unintended negative consequences of AI systems.

Why is automation ethical?

Used correctly, automation can improve working life for your team. Therefore, the creation of business process automation is completely ethical — its goal is to improve working life for thousands of people across the world. Automation becomes unethical when you use it incorrectly in an unethical way.

SOME SALIENT POINTS FROM THE VATICAN'S ARTIFICIAL INTELLIGENCE SYMPOSIUM (Nov 2, 2021, by James F. Keenan)

1. AI is highly competitive against humans. The pace of progress in machine learning, databases and hardware are all but irreversible and will profoundly affect humanity's future;
2. Machines are about 'doing', not about 'being'. They cannot fully replace humans;
3. AI designers must be accountable and transparent in their work;
4. IEEE (Institute of Electrical and Electronics Engineers) is an excellent resource for developing ethical guidelines for holding designers and researchers responsible;
5. We need to have an equitable distribution of AI resources and outcomes to fight against the profit-driven world of technology. AI could not force us to act, yet it can manipulate and confuse us. AI could not suffer, could not be intersubjective, needed to be regulated, yet a few years in the future we could have AI taking the role of the resident director, therefore, acting as a human person;
6. We like regulation or line-drawing, yet we are easily inclined to crossing a boundary.

IEEE Code of Ethics (Institute of Electrical and Electronics Engineers)

The following is from the IEEE Policies, Section 7 - Professional Activities (Part A - IEEE Policies).

7.8 IEEE Code of Ethics

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

I. To uphold the highest standards of integrity, responsible behavior, and ethical conduct in professional activities.

1. to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and to disclose promptly factors that might endanger the public or the environment;

2. to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;

3. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

4. to avoid unlawful conduct in professional activities, and to reject bribery in all its forms;

5. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, to be honest and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others;

6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

II. To treat all persons fairly and with respect, to not engage in harassment or discrimination, and to avoid injuring others.

7. to treat all persons fairly and with respect, and to not engage in discrimination based on characteristics such as race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;

8. to not engage in harassment of any kind, including sexual harassment or bullying behavior;

9. to avoid injuring others, their property, reputation, or employment by false or malicious actions, rumors or any other verbal or physical abuses;

III. To strive to ensure this code is upheld by colleagues and co-workers.

10. to support colleagues and co-workers in following this code of ethics, to strive to ensure the code is upheld, and to not retaliate against individuals reporting a violation.

Adopted by the IEEE Board of Directors and incorporating revisions through June 2020.

CH 9: THE ROLE OF CONSCIENCE

Different Notions/ concepts of Conscience

In the Hebrew Scriptures, conscience is typically understood as the feeling in one's heart, or of the voice of God in one's soul.

In the "Book of the Dead", the Egyptians put forward an examination of conscience, or rather profession of innocence, before the Supreme Judge after death.

The ancient Greek Penandros said that "a good conscience" was true freedom.

In the literary traditions of the Upanishads, Brahma Sutras and the Bhagavad Gita, conscience is the label given to attributes composing knowledge about good and evil, that a soul acquires from the completion of acts and consequent accretion of karma over many lifetimes.

The Chinese concept of Ren, indicates that conscience, along with social etiquette and correct relationships, assist humans to follow The Way (Tao) a mode of life reflecting the implicit human capacity for goodness and harmony.

In the Pali scriptures, Buddha links the positive aspect of conscience to a pure heart and a calm, well-directed mind. It is regarded as a spiritual power, and one of the "Guardians of the World". The Buddha also associated conscience with compassion for those who must endure cravings and suffering in the world until right conduct culminates in right mindfulness and right contemplation.

The Islamic concept of Taqwa is closely related to conscience. In the Qur'ān verses 2:197 & 22:37 Taqwa refers to "right conduct" or "piety", "guarding of oneself" or "guarding against evil".

Definition of Conscience

Conscience existing as a faculty of the human soul is to grasp what is truly good and what is truly evil. It does not exist apart from man's intellect or free will. Contrary to some popular misconceptions, conscience is not the "source" of morality, but rather is its "servant".

The term "conscience", Latin "conscientia" (con =with; scientia = knowledge) and Greek "suneidenai" (sun =to share; eidenai = knowledge) means to share knowledge with oneself. It implies the external sources of morality, such as, God or religions, or the influence of one's culture or of one's upbringing in conscience-formation. Conscience, therefore, involves introspection, awareness of one's behavior, and self-assessment, leading to feelings of remorse when a person commits an act that conflicts with their moral values.

The Second Vatican Council (1962–65) describes, "Deep within his conscience man discovers a law which he has not laid upon himself but which he must obey. Its voice, ever calling him to love and to do what is good and to avoid evil, tells him inwardly at the right moment: do this, shun that. For man has in his heart a law inscribed by God. His dignity lies in observing this law, and by it he will be judged."

Conscience may be defined as the practical reason employed when applying moral convictions to a situation ("critical conscience"). In purportedly morally mature mystical people who have developed this capacity through daily contemplation or meditation combined with selfless service to others, critical conscience can be aided by a "spark" of intuitive insight or revelation (called *marifa* in Islamic Sufi philosophy and *synderesis* in medieval Christian scholastic moral philosophy).] Conscience is accompanied in each case by an internal awareness of 'inner light' and approbation or 'inner darkness' and condemnation as well as a resulting conviction of right or duty either followed or declined.

St. Thomas Aquinas regarded conscience as the application of moral knowledge to a particular case.

Albert Einstein viewed an enlightened religious person as one whose conscience, 'the inner voice', reflects that he "has, to the best of his ability, liberated himself from the fetters of his selfish desires and is preoccupied with thoughts, feelings and aspirations to which he clings because of their super-personal value."

Conscience's function

Conscience is ordered to the task of holding to the most fundamental of all moral precepts: do good and avoid evil. Informed by the teaching/ tenets of each religion or by the principles of right and wrong, which are perceptible to the human mind from the natural law, conscience renders a judgment about the goodness or evil of a particular act or choice in the specific circumstances of the moment. Conscience then evaluates the choice one has made to determine whether or not the good is chosen and the evil shunned.

Because all men and women suffer the effects of sin, the human intellect is fallible. As a result, it is possible for the judgment of conscience to be in error. Out of ignorance or even faulty reasoning, conscience may not be able to render a judgment that conforms to objective moral truth.

Sometimes this ignorance can be willful or vincible. In such a situation, a person would have had the means available to overcome a lack of knowledge or misunderstanding of a particular moral precept, yet would have rather freely chosen to remain in ignorance. A person acting on the basis of vincible ignorance is morally responsible for the choices that are made.

On the other hand, there are times when a person's lack of awareness or misunderstanding of a particular moral obligation is not voluntary and, therefore, beyond the ability of the person to overcome it. This is termed invincible ignorance. A person acting on the basis of such invincible ignorance is not morally responsible for his actions or choices. Yet, even though he may not be morally responsible for the evil he committed, he and others may be affected by it. Sadly, such situations often have a serious and negative impact upon one's spiritual life, disrupting union with the Absolute and others.

Leo Tolstoy held that the only power capable of resisting the evil associated with materialism and the drive for social power of religious institutions, was the capacity of humans to reach an individual spiritual truth through reason and conscience.

The Rights of Conscience and Conscientious Objections

Definition of Conscientious Objection

John Rawls, in his *A Theory of Justice*, defines a conscientious objector as an individual prepared to undertake, in public (and often by reference to contrary foundational social virtues (such as justice as

liberty or fairness) and the principles of despite widespread condemnation), an action of civil disobedience to a legal rule justifying it (also in public) morality and law derived from them. Rawls considered civil disobedience should be viewed as an appeal, warning or admonishment (showing general respect and fidelity to the rule of law by the non-violence and transparency of methods adopted) that a law breaches a community's fundamental virtue of justice. He must not be forced to act contrary to his conscience. Nor must he be prevented from acting according to his conscience, especially in religious matters"

The Catholic Church has always defended the conscience rights or the freedom of conscience. Man must not be forced to act contrary to his conscience. Nor must he be prevented from acting according to his conscience, especially in religious matters.

The United Nations Universal Declaration on Human Rights (UDHR) refers to conscience in the following articles:

Article 1: All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood

Article 2: Everyone has the right to freedom of thought, conscience and religion; this right includes freedom to change his religion or belief, and freedom, either alone or in community with others and in public or private, to manifest his religion or belief in teaching, practice, worship and observance

Article 3: Everyone shall have the right to freedom of thought, conscience and religion. This right shall include freedom to have or to adopt a religion or belief of his choice, and freedom, either individually or in community with others and in public or private, to manifest his religion or belief in worship, observance, practice and teaching

These articles provide international legal obligations protecting conscientious objectors from service in the military.

Examples of Conscientious Objections

St. Thomas More was executed for refusing to submit to the religious authority of English King Henry VIII, citing that he could not do so in good conscience.

In Nazi Germany/Austria Franz Jagerstatter refused to participate in the Nazi military, and for this he was beheaded.

During the Vietnam War, US Army soldier Louis Negre petitioned for conscientious objector status, stating that because of his Catholic faith and conscience he could not participate in the Vietnam War, which he considered to be unjust. Negre lost his case in the US Supreme Court; however the decision was not unanimous, with Justice William O. Douglas dissenting.

Sister Agnes Walsh, a Daughter of Charity, is remembered for her heroism in France during World War II. In 1943, when France was occupied by German Nazis, the search for Jews began. In the face of grave peril, Sister Agnes convinced her mother superior to open their convent and offer refuge to a Jewish family. The sisters did the right, but very challenging, thing when many would have told them to take the easy way out.

Kimberly Rivera, a private in the US Army and mother of four children who, having served 3 months in Iraq War decided the conflict was immoral and sought refugee status in Canada in 2012 (see List of Iraq War resisters), but was deported and arrested in the US.

Rosa Parks similarly acted on conscience in 1955 in Montgomery, Alabama refusing a legal order to give up her seat to make room for a white passenger; her action (and the similar earlier act of 15-year-old Claudette Colvin) leads to the Montgomery bus boycott.

Rachel Corrie was a US citizen allegedly killed by a bulldozer operated by the Israel Defense Forces (IDF) while involved in direct action (based on the non-violent principles of Martin Luther King Jr. and Mahatma Gandhi) to prevent demolition of the home of local Palestinian pharmacist Samir Nasrallah.

World Conscience

Definition

Conscience, the inner voice or the voice within, is a concept in national and international law. Being increasingly conceived of as applying to the world as a whole, it has motivated numerous notable acts for the public good and been the subject of many prominent examples of literature, music and film. It is properly and widely called "World Conscience".

For Edward O Wilson, world conscience is a concept that overlaps with the Gaia hypothesis , advocating a balance of moral, legal, scientific and economic solutions to modern transnational problems such as global poverty and global warming, through strategies such as environmental ethics, climate ethics, natural conservation, ecology, cosmopolitanism, sustainability and sustainable development, biosequestration and legal protection of the biosphere and biodiversity.

The Green party politician Bob Brown expresses world conscience in these terms: "the universe, through us, is evolving towards experiencing, understanding and making choices about its future'

Notable Examples of World Conscience Objections

The American cardiologist Bernard Lown and the Russian cardiologist Yevgeniy Chazov were motivated in conscience through studying the catastrophic public health consequences of nuclear war in establishing International Physicians for the Prevention of Nuclear War (IPPNW) which was awarded the Nobel Peace Prize in 1985 and continues to work to "heal an ailing planet".]

Oscar Arias Sanchez has criticized global arms industry spending as a failure of conscience by nation states: "When a country decides to invest in arms, rather than in education, housing, the environment, and health services for its people, it is depriving a whole generation of its right to prosperity and happiness. We have produced one firearm for every ten inhabitants of this planet, and yet we have not bothered to end hunger when such a feat is well within our reach. This is not a necessary or inevitable state of affairs. It is a deliberate choice."

Mordechai Vanunu an Israeli former nuclear technician, acted on conscience to reveal details of Israel's nuclear weapons program to the British press in 1986; was kidnapped by Israeli agents, transported to Israel, convicted of treason and spent 18 years in prison, including more than 11 years in solitary confinement.

The Ambassador of Conscience Award, Amnesty International's most prestigious human rights award, takes its inspiration from a poem written by Irish Nobel prize-winning poet Seamus Heaney called "The Republic of Conscience." Winners of the award have included: Malala Yousafzai (2013), singer and social justice activist Harry Belafonte (2013) musician Peter Gabriel (2008), Nelson Mandela (2006), the Irish rock band U2 (2005), Mary Robinson and Hilda Morales Trujillo (a Guatemalan women's rights activist) (2004) and the author and public intellectual Václav Havel (2003).

Greta Thunberg received Human Act Award, on Earth Day, 22 April 2020, by the Human Act Foundation, for "her fearless and determined efforts to mobilize millions of people around the world to fight climate change." The USD100,000 prize money was donated to UNICEF and doubled by the Foundation.

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CH 11: SUSTAINABLE DEVELOPMENT GOALS

TOKYO OLYMPICS 2021 TO AWARD ATHLETES ENVIRONMENTALLY-FRIENDLY MEDALS MADE OF E-WASTE (06/30/2021, By BHAVISHYA MITTAL)

Everyday people around the world generates a lot of e-waste. Tokyo Olympics 2021 and Paralympics 2021, therefore, had tried to give back to society with greener innovations.



Over 6.21 million phones and 78,985 tons of small electronic gadgets were collected. They were then dismantled and around 5000 gold, silver, and bronze medals were made with the e-waste. Having got a disc of gold, silver, and bronze, the design of the medal was engraved on the disc, and was later polished to get the final product.

The organizers also introduced the navy-coloured checkered podium, the costumes for the volunteers, and the medal trays, all made from recycled plastic.

Thus, the Olympics in Japan contributed to an environmentally friendly and sustainable society.

[<https://www.essentiallysports.com/tokyo-olympics-2021-to-award-athletes-environmentally-friendly-medals-made-of-e-waste>; <https://english.kyodonews.net/tokyo/news/2021/06/608c6ae89b7f-eco-friendly-tokyo-olympic-medal-podium-unveiled-with-50-days-to-go.html>]

CH 12: PEACEBUILDING

JUST WAR THEORY

St. Augustine (4th century) said a war can be morally justifiable in some cases because it might prevent an even worse situation.

Pope Francis increasingly questioned the idea of a just war.

The Catechism of the Catholic Church states that there are strict conditions for legitimate defence by the military:

1. The damage inflicted by the aggressor on the nation or community of nations must be lasting, grave, and certain;
2. All other means for ending the conflict have failed;
3. There is a serious prospect of success;
4. And the use of arms cannot produce a graver evil than the one they are allegedly eliminating.

St. Thomas Aquinas's conditions for a Just War (1225 1274):

1. The war must have a just cause - eg against invasion, or for self-defence - and not to acquire wealth or power;
 2. The war must be declared and controlled by a proper authority, eg the state or ruler;
 3. The war must be fought to promote good or avoid evil, with the aim of restoring peace and justice after the war is over;
 4. The war must be a last resort when all peaceful solutions have been tried and failed, e.g., negotiation;
 5. The war should be fought with 'proportionality', with just enough force to achieve victory and only against legitimate targets, i.e., civilians should be protected;
 6. The good which is achieved by the war must be greater than the evil which led to the war.
- [<https://cruxnow.com/vatican/2022/07/pope-francis-confirms-right-to-defense-but-insists-on-rethink-of-just-war-doctrine>]

CH 16: CORRUPTION

PUBLIC ADMINISTRATION

DIGITALIZATION AND CORRUPTION IN THE EU MEMBER STATES.

A COMPARATIVE AND CORRELATIVE RESEARCH ANALYSIS

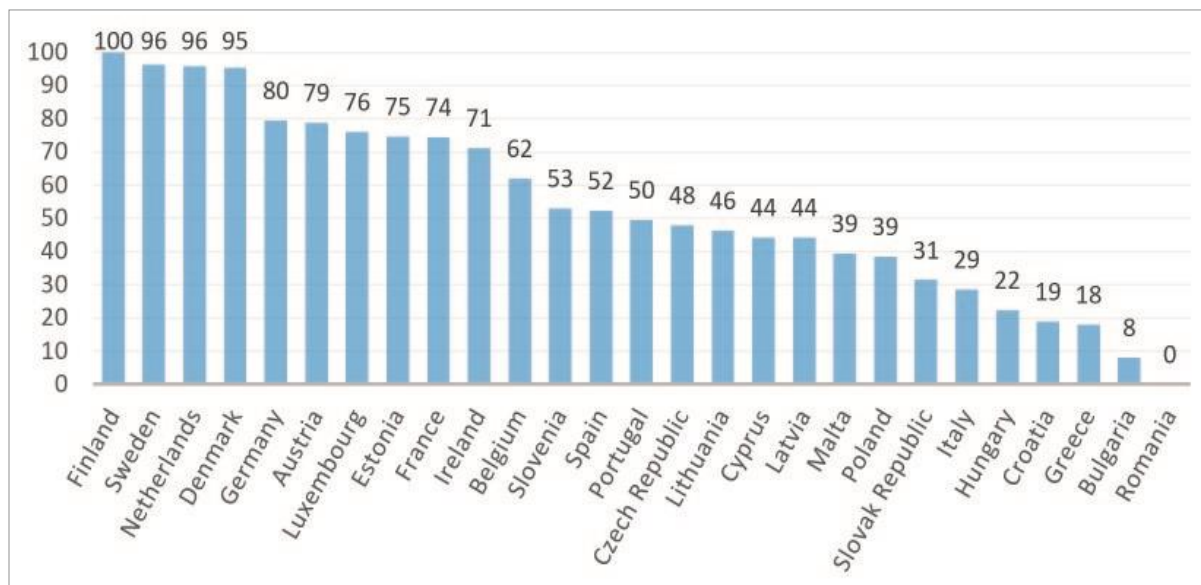
(This well-researched paper is the joint work of three professors, namely, Armenia ANDRONICEANU Professor, Faculty of Administration and Public Management, Bucharest University of Economic Studies, Bucharest, Romania, E-mail: armenia.androniceanu@man.ase.ro, ORCID ID: 0000-0001-7072-7019; Irina GEORGESCU, Associate Professor, Department of Informatics and Economic Cybernetics, Bucharest University of Economic Studies, Bucharest, Romania E-mail: irina.georgescu@csie.ase.ro, ORCID ID: 0000-

0002-8536-5636; Jani KINNUNEN, Researcher, Department of Information Systems, Åbo Akademi University, Turku, Finland, E-mail: jani.kinnunen@abo.fi, ORCID ID: 0000-0002-0154-6617. It is first published online in February 25, 2022.)

The burdensome, complicated and detailed statistical methods have been put aside for easy.)

The three great researchers have done a praise-worthy work on this topic. Though the focused area is the EU member States, yet, I think, it could very well be applied to our ASEAN Community. Thailand is therefore included.

Having putting forward the research questions, the key hypothesis, the research methods and data, the authors lay out their findings in Figure 2: Correlation Index of Corruption and Digitalization (CICD) in the EU member States.



The index values are scaled between 0 and 100 by Min-Max normalization. Figure 2 visualizes the ordered CICD values for EU countries. Nordic countries show the greatest values suggesting that they are digitalized and the most effective in terms of lack of corruption, Finland achieving the largest CICD =100.0, while Bulgaria (CICD =8.0) and Romania (CICD =0.0) are the least digitalized with relatively high corruption indicators. Romania has the smallest values for V8 (Human capital index) and V9 (E-government) as well as for V3 (Regulatory quality index) and V4 (Government effectiveness). Bulgaria also has very low values for digitalization and the lowest values of the EU states for V1 (Control of corruption) and V5 (Rule of law index).

These results answer the two research questions, as they confirm the differences between EU member states, both in terms of the degree of digitization associated with corruption, but also the fact that digitization, in the states investing in it, is a success factor in the fight against corruption. The results show that corruption was persistent in Europe amid the Covid-19 pandemic during 2019–2020. This was also confirmed by Transparency International, with the launch of the report on the Corruption Perceptions Index in 2020 (Transparency International, 2020). The results of our research show that the place recorded in the Corruption Perceptions Index (CPI) in 2020 is linked to how a country meets the challenges posed

by the pandemic. States with a good ranking seem to invest more in the healthcare system and are less likely to violate democratic and institutional rules or the rule of law.

Preventing or reducing corruption in public institutions is significantly influenced by public managers and elected politicians. They can develop anti-corruption strategies, policies, and tools and make internal changes to control and reduce corruption.

There are a variety of internal and external anti-corruption measures that can be implemented in public institutions both by civil servants and politicians. They are:

1. Establishing the core values and integrity codes for effective and honest preventive conduct;
2. Elaborating the codes of conduct for civil servants as a component of the employment contract;
3. Creating internal commissions to identify the acts of corruption of officials and to prosecute them;
4. Collaborating with specialized institutions involved in the procedure of investigating corruption in the public institution;
5. Developing strategies for both repression and prevention of corruption and others.
6. Blocking the participation of corrupt organizations in public tenders by public managers and politicians;
7. Organizing training programs for officials to prevent acts of corruption and to know the sanctions applied for corruption;
8. The behaviour of public managers and politicians regarding digitalization and corruption significantly influences both the content of the changes determined by digitalization and the intensity of corruption in the public institutions they lead.

Conclusion

Comparisons between states show that digitizing the administration is one of the most effective ways to reduce corruption in the public sector. This conclusion underlines the fact that state administrations should design and implement appropriate strategies and policies for the integration of large-scale digital applications. The countries that do not prioritize the cross-cutting integration of technology at all levels of the economy and society will lose important opportunities and will suffer.

By digitizing the administration and reducing corruption in public institutions, EU states are moving towards a digital society and economy. Digitalization brings with it new forms of organization, new managerial models and types of institutional processes, new social mechanisms, new instruments for making reforms in public administration, new leadership as well as a new type of values for society.

CH 18: ENVIRONMENTAL ISSUES IN THAILAND

GROUND WATER IN THAILAND

Thailand has groundwater storage of 1,130,000 Mm³ (million cubic meters) and a surface storage of 76,000 Mm³. The agricultural sector is the main user of surface water (70% of the total). There are 25 main drainage basins, which are included in these six groundwater basins: North, Upper Central, Lower Central, Northeast, East and South.

The main hydric problems faced by the Water Authority are:

1. Pollution (nitrates from agricultural sources in shallow aquifers, organic compounds from the petrochemical industry in coastal aquifers to the south-east of Bangkok, cadmium and fluoride in the north-west of the country, sodium chloride in the east and northeast, and arsenic in the south and problems of seawater intrusion along the coastline);
2. Floods (mountainous areas in the north, lower central plain, and south of the country);
3. and droughts (mainly in the north eastern area).

Groundwater Use

The current groundwater abstraction, in the whole country, is 11,047 Mm³-year⁻¹: 4,840 Mm³ for agriculture (44%), 4,085 Mm³ for industry (37%), and 2,122 Mm³ for domestic use (19%). Groundwater is used during the two dry seasons and mainly in rural areas. According to the National Statistic Office, in 2008 there were 1,405,401 dug wells and 738,406 groundwater wells.

Environmental Impacts

For a long period, there has been extraction of groundwater at a rate higher than that could be recharged naturally, and has caused three main environmental problems: 1) a decline in groundwater levels, 2) land subsidence, and 3) seawater intrusion.

Decline in Groundwater Levels

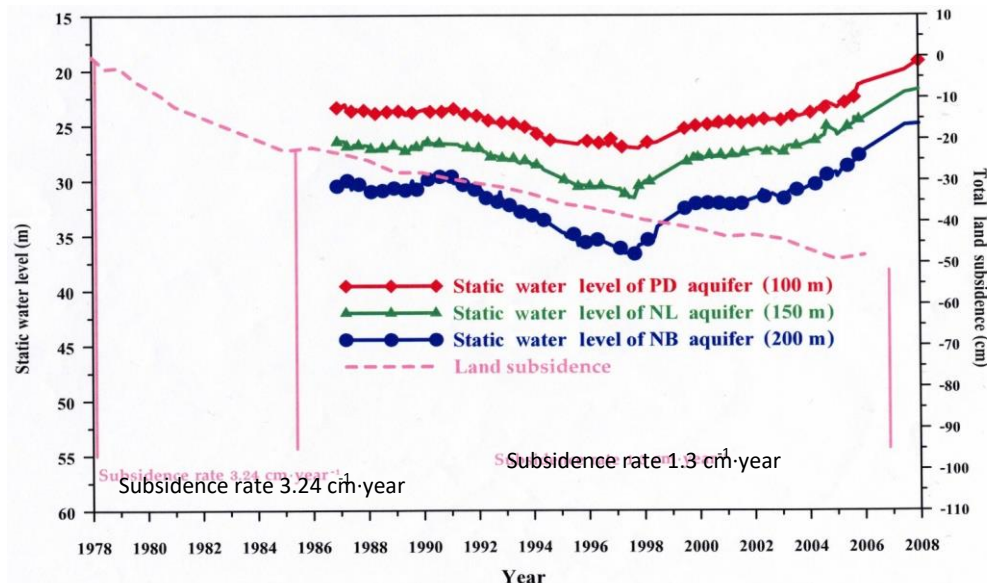


Fig. 5 Water level from three major aquifers and total land subsidence in Central Bangkok

Source: Department of Groundwater Resources, Ministry of Natural Resources and Environment, Thailand. (PD = Phra Padaeng, NL = Nakorn Luang, NB = Nonthaburi)

The Department of Groundwater Resources has registered the water level from three major aquifers and total land subsidence in Central Bangkok (Fig. 5). There is a clear relationship between groundwater level and land subsidence.

By 2004, groundwater levels generally declined considerably in the Chao Phraya-Tha Chin Basin due to extensive groundwater pumping. In some areas of Amphoe Krathum Baen and Samut Sakorn, the water levels were at 65-70 m below ground surface. After the groundwater conservation charge is introduced, the water levels had significantly recovered between 2.6 m·year⁻¹ and 3 m·year⁻¹ and in 2008 coming up to 28-48 m below ground surface. However, in other areas such as Amphoe Muang Samut Sakorn, this recovery was still low due to intense groundwater pumping.

Land Subsidence

A large area in Bangkok and its surroundings is dealing with problems of land subsidence due to high groundwater extraction. The major subsidence is in an area in the eastern part of Bangkok where the subsidence rate was as high as 10 cm·year⁻¹ in the 1978-1981 period. In central Bangkok, subsidence reached 5-10 cm·year⁻¹ throughout the same period. After the Groundwater Act was enacted in 1977 and strict control measures on groundwater extraction introduced, the rate of land subsidence reduced to less than 5 cm·year⁻¹. In 2008, it was below 3 cm·year⁻¹ in Bangkok and its neighboring provinces.

Seawater Intrusion

There are areas along the coastline which have seawater intrusion problems. Groundwater in Samut Prakan (to the south of Bangkok), for instance, has become brackish, or even salty in some layers. In some areas, the seawater not only intrudes into the aquifers but also leaks from one layer to the other from groundwater wells that are not properly sealed.

Groundwater in Bangkok

Bangkok is known as the Venice of the East on account of its great number of canals connected with the Chao Phraya, the city's main river. The population uses the water in those canals as well as rain water for daily use. However, water problems usually occurred in dry season due to canal water became salty, dirty and unsafe for drinking and use for other activities. Occasionally, it caused an outbreak of fatal cholera. In 1909, a project to supply the city of Bangkok with treated drinking water was promoted by King Rama V. The project was completed in 5 years and in 1914, the Bangkok Waterworks became the first drinking water distribution company for Bangkok citizens. In 1967, Bangkok Waterworks was turned into the MWA (Metropolitan Waterworks Authority), a state company under the orbit of the Ministry of Interior, which is responsible for clean disinfected water production, transmission and distribution to people living in three adjoining provinces: Bangkok, Nonthaburi and Samut Prakan. The company slogan is "Tap water is drinkable everywhere". Water is collected from the canals rather than reservoirs and is distributed through tunnels (20 m deep) or pipelines (3 m to 4 m deep).

In conclusion we can say that a comprehensive plan of water management is necessary. One efficient way of water management is the abolition or the reduction of groundwater abstraction.

[<http://www.davidpublisher.com/Public/uploads/Contribute/55078898cb5e0.pdf>]