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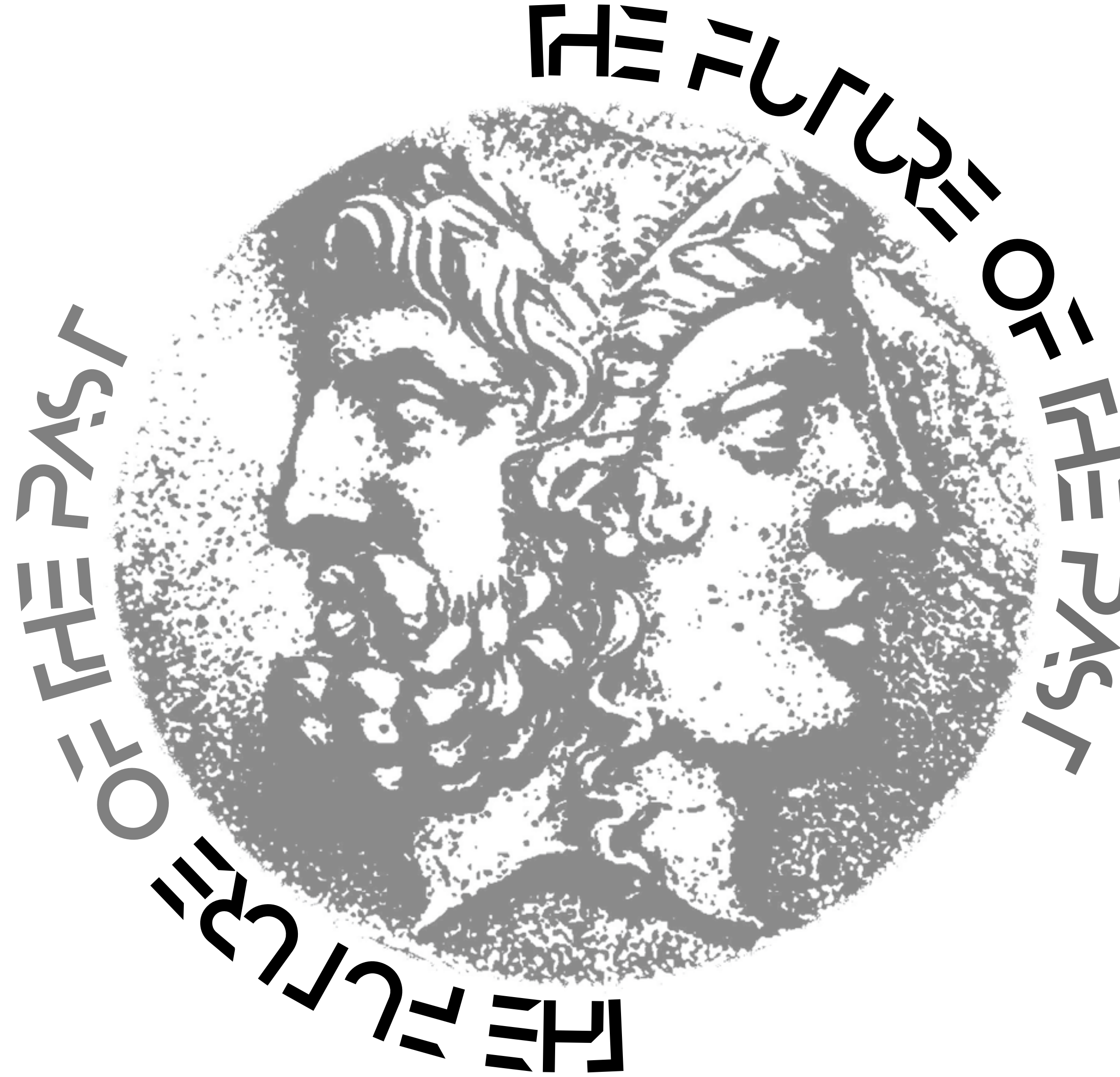

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Post-nuclear environments and non-anthropocentric art

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Post-nuclear World War II art is generally anthropocentric, documenting and commemorating consequences of nuclear warfare. It cautions the future for the devastation of that particular past. Atomic power has, since the mid-20th century, been applied widely in ways other than for warfare. Germane to this is the risk of accidental nuclear malfunction. Compared with the aftermath of the atomic detonations in Japan in 1945, recent atomic explosions at Chernobyl (situated in the Ukraine and Belarus), as well as Fukushima in Japan, left various man-made structures as well as large tracts of the natural environment surrounding the nuclear plants reasonably intact. This has offered researchers a unique opportunity to observe and document post-nuclear environments. Japanese art photographers Masamichi Kagaya, Shimpei Takeda and Yoi Kawakubo, scientifically informed by events in such doomed ecosystems, are using post-nuclear events as reference and inspiration to produce works that make the invisibility of radioactivity visible by being more inclusive of species other than humans, inclining towards non-anthropocentric, post-nuclear art.
Keywords: post-nuclear environments, post-nuclear art, non-anthropocentric art, Masamichi Kagaya, Shimpei Takeda, Yoi Kawakubo.

被ばく環境と非人間中心的アート
核戦争後の第二次世界大戦の芸術（アート）は一般的に人間中心的で、核戦争の結果を記録、記念し、その過去の荒廃を未来に向けて警告しているものである。20世紀半ば以降、原子力は戦争以外の分野で広く利用されるようになり、それには原子力の誤作動による事故のリスクが伴うこととなった。1945年の日本への原爆投下後の状況と比べ、ベラルーシ共和国に隣接するウクライナのチェルノブイリ、及び日本の福島で起きた最近の原発事故においては、原子力発電所周辺の建造物や自然環境の大部分は形を残すという結果となり、研究者にとっては被ばく環境を観察、記録できるまたとない機会となった。最近の原発事故に触発され、このような不運に見舞われた生態系での事故から得た科学的な知識を基に、日本のアートフォトグラファーである加賀谷雅道、武田慎平、川久保ジョイは、非人間中心的な戦後芸術を志向し、人間以外の種を包括的に捉えることで、普段は目に見えない放射能を可視化する作品を製作している。
キーワード：被ばく環境、戦後芸術、非人間中心的アート、加賀谷雅道、武田慎平、川久保ジョイ

An anthropocentric view regards the human being as the central fact of the universe; assumes that humans are the final aim and end of the universe; and interprets everything in terms of human experience and values.[1] Regarding the human race as the final aim and end of the universe is, in real terms, egocentric and simply not sustainable. This article proceeds by positioning non-anthropocentricism with regard to the Anthropocene epoch which now prevails. This is followed by contextualising altered (rather than novel) environments or ecosystems as a result of nuclear events, in particular the 2011 atomic event that occurred at Fukushima, Japan. Unexpected developments in such altered environments from which humans are restricted or excluded form the basis of a discussion of post-nuclear art inclining towards non-anthropocentricism, and why this should be deemed significant. In this article photography is considered to be art.

Anthropocene is considered as a potential geological epoch, preceded by Holocene, its proponents arguing that humans exert as much force geologically and environmentally, as do natural forces.[2] Debates surrounding the start-up date of the Anthropocene are varied, with the most extreme suggesting that the first human use of fire modified ecosystems, some 1.8 million years ago (Glickson 2013: 89-92); between 1945-55, when economic activity with commensurate human impacts started to be noticed on a global scale;[3] and the most recent being the year 2000, when the concept was first proposed by Crutzen and Stoermer to emphasise the central role and effect of mankind on ecology and geology (Corlett 2014: 37).

Corlett (2014: 36-7) explains that, from an environmental viewpoint, the pervasiveness, variety and magnitude of human impacts leaves little doubt that the Earth and its inhabitants are currently in a distinct time period. In this regard, critical elements of the biophysical environment, inter alia ocean acidity, global and regional nitrogen (N) cycles, extinction rates and greenhouse gas concentrations now fall outside of Holocene ranges – thus positioning the Anthropocene as a distinct geological epoch. Markers that distinguish what is understood to be germane to the Anthropocene could include anthropogenic deposits and landforms, novel minerals, nonbiodegradable plastics debris, subsurface changes and bomb-test isotopes. Insidious anthropogenic global change has seemingly been lumped together under the banner of the Anthropocene concept. Attempts to hold countries or organisations accountable for measurable detrimental consequences as a result of unbridled harvesting of the Earth's resources have proven to be ineffectual. Steffen *et al.* (2011) explain how the two biggest attempts at global environmental governance, the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC) illustrate humanity's unwillingness and/or inability to embrace planetary stewardship.[4] At stake here is the Earth's ability to cope with massive anthropogenic change, otherwise referred to as global sustainability, which is discussed in the following section.

Global sustainability and more inclusive terms

Between February to August 2020 global efforts to contain a highly contagious virus (COVID-19) drastically reduced global human activity with commensurate restricted human movement. A rare opportunity arose to document "before-and-after" observations of ecological impacts. At the nub of some unexpected and fascinating findings was the absence of humans and/or human activity.

There is something satisfying about the map illustrated in figure 1 since it offers an alternative state, in this regard reduced nitrogen dioxide emissions in China as a result of reduced human activity. Note that the recorded levels portray what is possible to do within a month – the image on the left depicts emissions from January 1 to 20; the image on the right February 10 – 25 2020. Yet we know that the depicted state of those emissions (as well as the state in which China found herself) is a transient one, since the "absent" humans are still alive and at some future stage a NASA snapshot of the same area will yet again reflect massive nitrogen oxide emissions. What the map below illustrates is a preferred state (reduced nitrogen oxide emissions) which was only possible because human lives were under threat and were thus forced to temporally restrict their movement to contain spread of the disease – thus an egocentric motivation. What if the world reacted to global sustainability – thus a more ecocentric motivation – in the same coordinated way that it has to the COVID-19 pandemic?

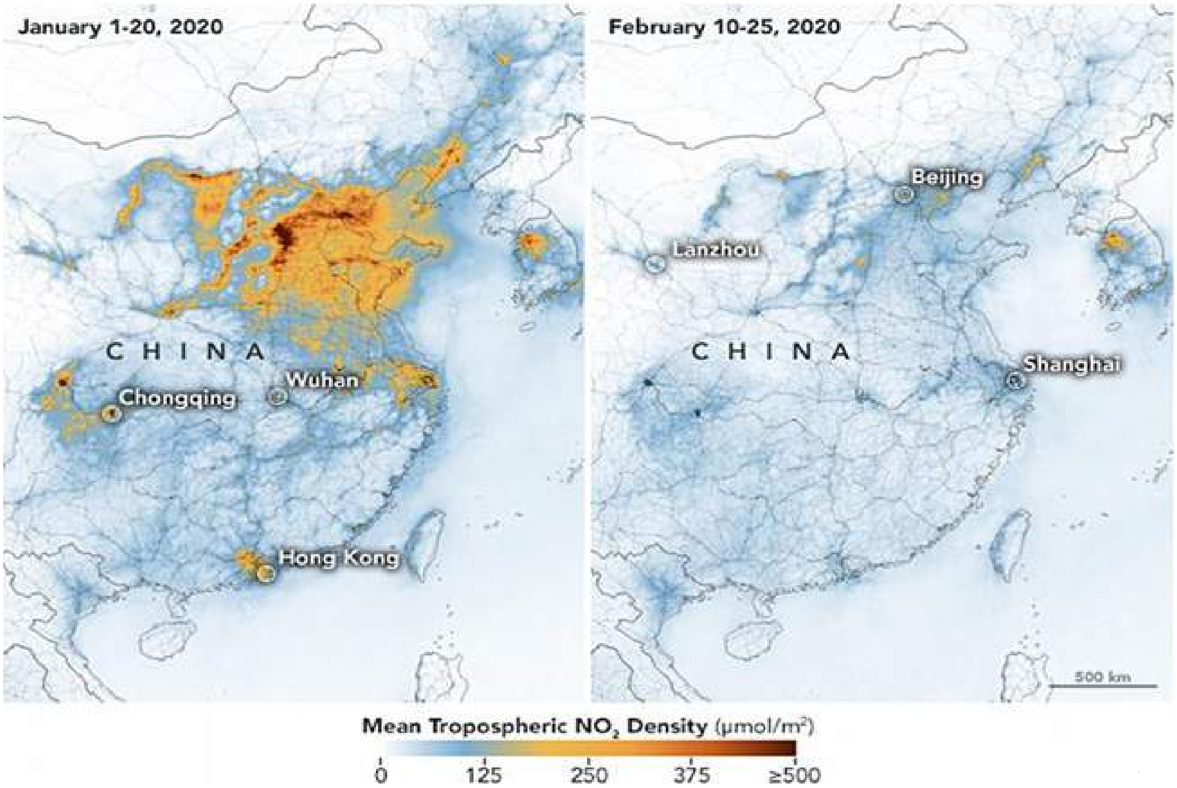

Figure 1
Airborne nitrogen dioxide plummets over China
(retrieved from the public domain earthobservatory.nasa.gov).

The glaring reality is that global sustainability has remained much as it did prior to the pandemic, since human population growth, coupled with modern economic systems, are built on huge future claims against the Earth's inherently limited ability to provide resources. The Population Media Centre at Antioch University offers a sobering account of human sapiens as an ecological phenomenon: "The sheer size of human civilization – 7.8 billion people – is already daunting. Since the first suspected case of COVID-19 appeared in November 2019, the global population has increased by 27 million people – roughly the amount of people who live in Texas. By 2100 the UN projects an additional 3 billion people will be making claims against the planet – think of this increase as the same number of people who live in the United States, India, and China. This results in a population size of 10.8 billion by 2100" (Bish 2020: 2).

Gregory Mikkelson, professor in the School of Environment, McGill University, Canada, refers to anthropocentrism as being patently defective (2019: 136-7). He is a proponent of ecocentrism and promotes a holistic approach of an Earth with thriving populations of all ten million species, including humans. My position vis-à-vis the importance of the human race versus any and all other species on Earth lies somewhere on a continuum, closer to an extreme bio- or ecocentric view in which humans are merely another species, rather than the opposite position that only human beings matter (thus an anthropocentric view as described in the first paragraph of this article). I argue for overall diversity and integrity within a species or ecosystem.[5] However, the expansion of human societies beyond apparent biophysical limits is placing the Anthropocene in crisis and the diversity and integrity for which I argue is becoming chimeric. I concur with Bish (2002: 3-4) who points out that the scale of human activity is oversized relative to the ability of the Earth to provide for humans and other life forms and that the product of all human history to date has resulted in many grotesque bottom lines: the extermination of fellow species, geological scale impacts and radical intraspecies inequity.

It is challenging to navigate through available options when faced with such harsh realities, without becoming stuck in the irretrievably lost and romantic past or the opaque hopelessness of embracing any possible novel future. Serenella Iovino (2010: 29-30), from the department of Environmental Humanities at the University of North Carolina, asserts that the world that once seemed to be endless appears instead to be facing its end. She pleads for humans to radically redesign their future scenarios in more inclusive terms – both ethically and culturally – and for the humanities (in this regard meaning literature, philosophy, art, et cetera, as distinguished from the sciences) to assist where the environment and society intersect. To this end she suggests an interdisciplinary approach that calls upon literature as an application of ethics with regard to the egotism of the human race and its seeming loss of aptitude to define itself in relation to the specific environment that surrounds it. My plea is also inter- and multidisciplinary here, for the arts to address the egotism of the human race and its seeming inability to redefine itself and face the legacy of its self-made destruction. Iovino (2010: 31) suggests that in the age of ecological crisis, literature can choose to be "ethically charged" and can communicate an idea of ecological responsibility – which, in the age of ecological crisis is global. The same applies to the visual arts.

In this article I have chosen to position post-nuclear environments as a rather extreme example of a future emerging from a particular past. Radioactivity is not a modern phenomenon – on the contrary, Dadachova and Casadevall (2008: 525) assert that for people living in the United States of America today, 90% of the annual radiation dose comes from natural sources such as cosmic radiation and radioactive rocks. Yet, radionuclides introduced into the environment anthropogenically are one of the major concerns to human health and ecotoxicology. Dighton, Tugay and Zhdanova (2008: 109) suggest that fallout from nuclear weapons, waste from nuclear energy-generating industries and from medical uses of radioisotopes contribute to radionuclide contamination of the environment. Far more invasive are nuclear "accidents" or events, such as those that occurred at Three Mile Island, Pennsylvania (1979), Chernobyl (1986) and Fukushima (2011). Post-nuclear environments can be considered the most doomed environments on Earth, yet they have served, and continue to serve as inspiration for artists, as this article will bear out. Nuclear power became a reality during the twentieth century – the world could not have imagined the devastating effects (and consequences) that the detonation of atomic bombs would unleash during 1945. Those nuclear events changed the course of history and served to caution the future for the devastation of that particular past.

Nuclear events of 1945

Two American atomic assaults on Japan at the end of World War II (1945) can be considered of the most devastating in scale that humanity has endured and witnessed. Quantifying human loss may seem gratuitous and callous considering the scale of the inarguable devastation of Hiroshima (6 August) and Nagasaki (9 August) and at the time, the unimagined post-nuclear consequences. In the pursuit of a complete understanding of the past, however difficult, quantification broadens context. The difficulty lies in the uncertainty of how people died – some immediately due to evisceration, some due to collapsing buildings, some in the weeks following the detonations due to burns and other injuries and those who died due to radiation-induced cancers months and even years later. Adding the latter to the tally alters the human toll.[6] The generally accepted figure of the Hiroshima death toll of 140, 000 remains contested, possibly due to unquantified population figures before the bombing, the chaos that followed the bombing and bodies that were incinerated due to the impact of the blast. Atkins (2018) refers to 202,118 (as at 1998) registered deaths resulting from the Hiroshima bombing, a number that had swollen by 62,000 since the 1946 death toll of 140,000. Figure 2 offers a before and after glimpse of the total annihilation of Hiroshima. The estimated number of people killed by the "Fat Man" bomb which was detonated three days later at Nagasaki ranges from 39,000 to 80,000.

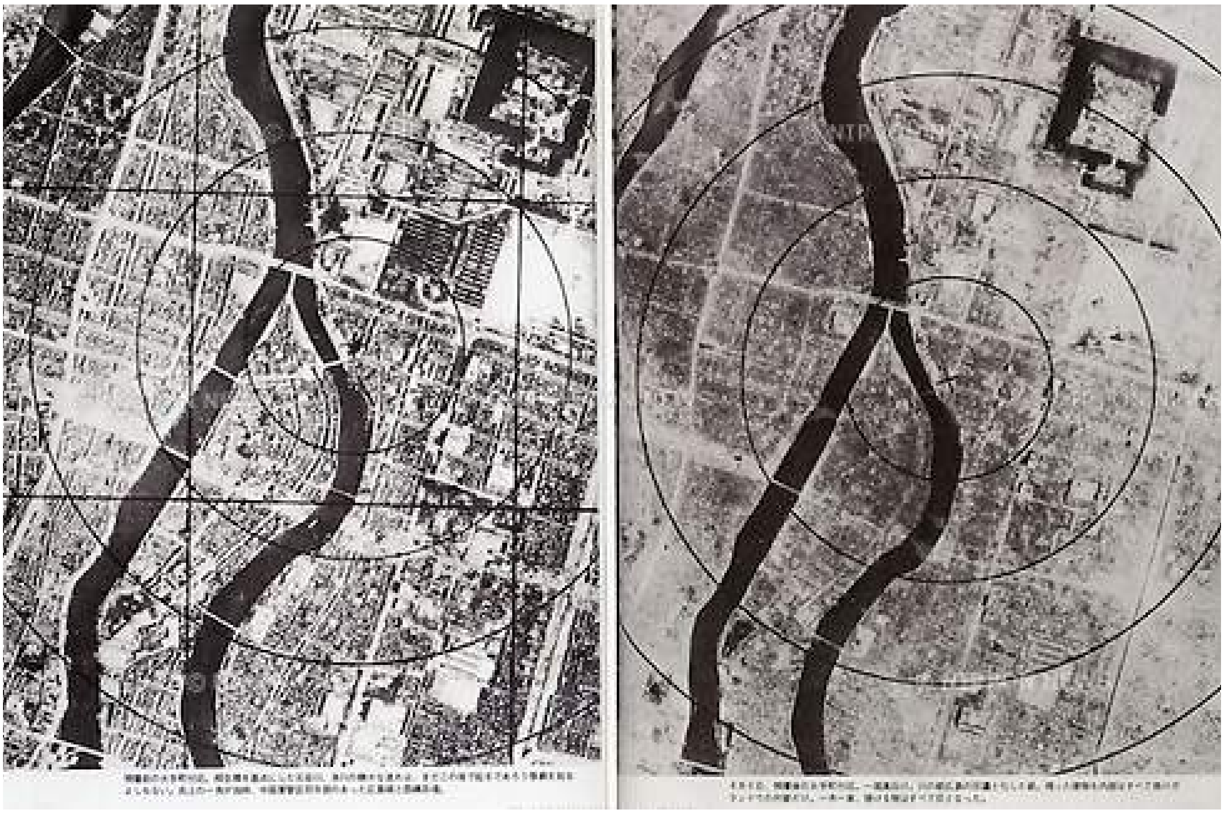

Figure 2
Aerial photo of before and after the atomic bombing of Hiroshima in 1945
(retrieved from the public domain: photo: Kingendai Photo Library/AFLO).

Considering the obscene levels of human trauma and loss experienced around those two events it is understandable that post-nuclear documentation of events and art, or art photographic expression, would be focused on the loss of human lives and environmental loss as it pertains to humans, thus proceeding from an anthropocentric position.

Recent atomic events

Some forty years later unexpected loss of human lives was again experienced due to an atomic event. The Chernobyl Nuclear Reactor Plant (ChNRP) situated in the Ukraine and Belarus experienced a disaster rated at seven (maximum).[7] On April 25, 1986, routine maintenance which was scheduled at V.I. Lenin Nuclear Power Station's fourth reactor went wrong. Zhdanova *et al*. (2000: 1421) explain that the protective covering of the reactor was blown off after an improperly supervised experiment with the water-cooling system (which had been turned off) led to a steam explosion, releasing radionuclides into the atmosphere. A plume of radiation spread across, not only Russia and Belarus, but also northern Europe. Heavy radioactive contamination of both the structure of the building and its immediate environment occurred. The main source of ongoing radioactive contamination at Chernobyl (+-10%) is a radioactive lava – a result of high-temperature interactions between nuclear fuel, the reactor core elements and building construction materials. That lava filled several locations in the lower regions of the original reactor building. Compared to the events referred to in 1945, the atomic blast allowed infrastructure to remain partly intact and after initial reported deaths, humans were evacuated, affording an unprecedented opportunity to observe and document changes to the manmade and surrounding (natural) environment.

More recently on 11 March 2011, a "triple disaster" - a magnitude 9 earthquake (the strongest since records began) – followed by a 28-meter tsunami wave which slammed into the Fukushima Daiichi nuclear reactor in Fukushima, Japan, created a nuclear accident and another high-radiation environment.[8] This event has come to be called 3.11, reminding of the 9.11 traumatic event in America. Radioactive materials were released after three nuclear reactors at the power plant melted down, contaminating around 9,000 square kilometres. The Japanese government declared a 20 km evacuation zone around the power plant and around 110,000 people were evacuated within two years (Sekizawa, Ichii and Kondo, 2015: 824). Impacts of the disaster were more difficult to assess than the Chernobyl nuclear disaster due to the unique co-occurrence of earthquake, tsunami and nuclear accident. Japan is unique in that it is the only country that has experienced the atomic bomb as well as nuclear accidents, and is dependent on nuclear energy.

At Fukushima, as at Chernobyl, humans were evacuated and the infrastructure was left reasonably intact. As with Chernobyl, an opportunity arose to observe post-nuclear effects on the infrastructure and the natural environment. In both of these atomic events referred to above, after evacuation, human lives have been protected by restricting human access to areas surrounding post-nuclear "hotspots". These areas are referred to as restricted zones. Biological scientists Timothy Mousseau and Anders Möller (2014) report that the chronic, multigenerational exposure to low-dose-rate radioactivity emitted by firstly Chernobyl, followed by Fukushima, offers a unique opportunity to conduct studies on the genetics of animals, who were left to organize themselves in both of those abandoned environments. In these areas – referred to as restricted zones – animals have been allowed to continue living without human interference in a seemingly undisturbed manner. The debate among scientists over the effects of low levels of ionizing radiation on wildlife is heated and political. Whereas the proliferation of wildlife in restricted zones does not exclusively imply that those are better off, it seemingly enables nature to reorganize itself. Is it fair to refer to an ecosystem that seemingly "repairs" itself as a novel ecosystem? Furthermore, when does an ecosystem become a "novel" ecosystem?

Does any doomed or failed ecosystem become a novel ecosystem?

The use of the "novel" concept suggests a counterpart – an historic or pristine alternative such as "wilderness", which tends to be a place that conservationists wish to preserve in as pristine a manner as possible. Conservationists Hobbs *et al.* (2006: 1-2) published an article in which the "novel ecosystem" concept was first referred to, and described their research as focusing on theoretical and management aspects of the "new ecological world". They further describe their research as exploring issues relevant to ecosystem types that contain new combinations of species. Those can arise through human action, environmental change and the introduction of species (whether deliberate or not) from other regions. It is interesting to note that they also refer to "emerging ecosystems" as resulting when species occur in combinations and relative abundances that have not occurred previously within a certain biome.

Murcia *et al.* (2014: 548) explain that new concepts that challenge existing paradigms drive science and innovation. They emphasise that such concepts need to be based on solid evidence, especially when they fundamentally affect how ecosystems, upon which all life depends, are managed. Since change is an inherent property of ecosystems and possibly because solid evidence is lacking, there does not seem to be consensus amongst scholars as to a definition of novel ecosystems. Hobbs *et al.* (2013: 58-60) describe a novel ecosystem as a physical system that, by virtue of human influence, differs from those that prevailed historically. Such systems have a tendency to self-organize and retain their novelty without future human involvement. Marris (2010: 13) refers to attempts at quantifying novel ecosystems (land within agricultural and urban regions that have no agricultural or urban use) as covering at least 35% of the globe.

I concur with Marris, Mascaro and Ellis (2013: 346) that referring to novel ecosystems has the potential to be a cunning propaganda tool to encourage humans to see evolving possibilities in environments that would otherwise be considered doomed or failed. On the other hand, Hobbs, Higgs and Harris (2014: 2) plead as follows: "[E]mbracing the increasing prevalence of altered ecosystems (whether these are called hybrid, novel, emerging, or something else) does not involve throwing away all current efforts in conservation and restoration. Rather, it should allow more reasonable discussion of the options available, the likelihood of success of different degrees of intervention, and the priorities for action."

Since the planet is undergoing rapid anthropogenic change, Marris, Mascaro and Ellis (2013: 346) suggest that the seeming absence of local human influence is an illusion and that, even though there might be some meaningful threshold beyond which an ecosystem changes into a novel ecosystem, such a threshold has yet to be determined and described.[9] One can also deduce that no systems are devoid of being novel (indeed, that degrees of novelty might be more accurate) and that a "novel" ecosystem is therefore not a distinct entity. This possibly renders the concept meaningless.

Lyons *et al.* (2020: 127) offer that, even though it may take decades or longer for ecosystem functions to recover from land-use legacies, some have demonstrated marked resilience when freed from anthropogenic pressures. When ecosystems respond positively to post-restoration processes this is often referred to as "rewilding". This mostly occurs under the auspices of governmental agencies and non-governmental agencies that take an active role in managing such areas, but may also occur when lands are abandoned (such as at the Chernobyl Exclusion Zone). In order to avoid any incorrect usage of terminology that remains as yet undecided by conservationists and ecologists I have elected to refer to the post-nuclear ecosystems of Chernobyl and Fukushima not as novel ecosystems but rather as "altered environments". These environments play host to ecosystems largely governed by human legacy and design which have, since human interaction has been restricted, "gone wild", "gone rogue", "rewilded", changed, mutated, become altered. The environments including and surrounding Chernobyl and Fukushima have undergone huge changes as a result of nuclear accidents. Some changes are visible, but others remain as yet invisible (yet detectable and in some cases made visible through technology) due to the nature of the particular contaminants. In the following section I discuss the nature of nuclear radiation and its effect on environments.

How nuclear radiation alters environments

For the layperson the effects of radionuclides on the environment are difficult to grasp, especially since radionuclides are invisible.[10] Feldhoff (2018: 15), who uses cartographic representations to illustrate the types and levels of radioactivity following the nuclear disaster at Fukushima, suggests that the perception of matters nuclear by people without a scientific background has a tendency to be irrational. Since this section of the article serves to create context towards a better understanding of altered environments as a result of nuclear radiation, a basic understanding thereof is deemed necessary. Bear in mind that each nuclear explosion or accident is unique, as is the damage experienced by an environment as a result of a particular nuclear event.[11] Such damage is referred to "radioecological" damage.

Agricultural radiologists Alexakhin *et al*. (2007: 418) explain that radioecological activity should be considered in relation to two phenomena: "On the one hand, Chernobyl radionuclides were the source of irradiation of plant and animal communities and, consequently, their irradiation damage. On the other hand, when released into the environment and then included into the trophic chains of biological cycling, the radionuclides became the source of contamination of environmental resources (soil, water, agricultural products, forests), the consumption of which, or contact with which, led to irradiation of humans". According to the same authors, at Chernobyl radionuclides were a source of irradiation of plants, animals, their communities and ecosystems in general (Alexakhin *et al.* 2007: 423). The severity of the effects of ionizing radiation caused various radiation-induced alterations, the severity of which depended on the dose rate, dose concentration and radiosensitivity levels.

Nuclear chemists Von Gunten and Benes (1995: 1) explain that the physical and chemical properties of radionuclides determine their behavior in the environment, as well as their uptake by the biosphere and the effect of their toxicity. This is referred to as their "speciation", rather than their gross concentrations and may include isotope composition, physical form and molecular composition. Speciation of radionuclides in the environment includes effects on the atmosphere, hydrosphere and lithosphere.[12] Speciation is furthermore influenced by the physical and chemical conditions of these three compartments, which are interconnected. Radionuclides are transported by water and wind (which may include sea spray and diffusion), which would make their distribution unpredictable and in some instances, relatively transient. Sources of airborne radionuclides include, inter alia, 1) Radon isotopes – radon is a noble gas, is produced on continental land masses and escapes from the earth's surface into the atmosphere; 2) interactions of cosmic radiation in the upper atmosphere; 3) nuclear weapons tests in the atmosphere which disappear from the atmosphere in time due to radioactive decay; 4) uranium mining, installations of the nuclear fuel cycle and nuclear reactors, which leads to a continuous global increase of their atmospheric concentrations; 5) coal burning; and 6) the re-suspension from soil and the sea by wind action.[13] Typical methods for the determination of speciation are thermodynamic (and kinetic) calculations, direct analysis of environmental samples (inclusive of in situ analysis) and model experiments, usually in laboratories.[14]

When matter interacts with alpha, beta and gamma radiations, positively charged ions and electrons are produced. There are various hand-held devices suitable for fieldwork that can detect radiation, measure ionization and produce observable outputs – the most common is the Geiger-Mueller counter, which collects the ionization product through a gas-filled tube.[15] Its use is limited since the Geiger counter does not distinguish between alpha, beta or gamma radiation. For detailed readings of, say, gamma radiation emissions, handheld isotope identifiers are required which use scintillation detectors such as sodium iodide (NaI).[16]

A nuclear explosion is characterized by the following effects on the environment: around 50% of the energy produces air blast (and shock); around 35% comprises thermal energy and around 15% of the energy is released as nuclear radiation. Around 5% of the latter is initial nuclear radiation (usually produced within a minute of the explosion) which is made up of gamma rays and neutrons – the final 10% of the total fission energy is residual nuclear radiation that is emitted over time.[17] In other words, there are immediate as well as delayed effects, which are calculated from the point of detonation. Immediate effects are blast (which produces a shock wave of air, changes in air pressure and high winds), thermal radiation (heat), which travels at the speed of light (causing "flashblindness", burns and fires), and prompt ionizing. These immediate effects all cause destruction within seconds or minutes of a nuclear detonation. Delayed effects include radioactive fallout which can last for hours or decades. Radiation effects can cause chromosomal damage, reduction in white blood cells, radiation sickness which can result in marrow and intestine destruction, heart failure and gastrointestinal and reproductive tract damage. Furthermore, it results in blood disorders, cataracts, malignant tumours and leukemia and keloids.[18]

At Chernobyl the major radionuclides released were caesium-134 (Cs134), caesium-137 (Cs137), strontium-90 (Sr87.62), plutonium-239 (Pu), ruthenium 103 (Ru103) and 106 (Ru106), tellurium-132 (Te132) and iodine 131(I131).[19] In relation to the radioecological consequences of the Chernobyl accident, two phenomena should be considered – firstly, radionuclides were the source of irradiation of plant and animal communities and thus their radiation damage; secondly, when radionuclides were released into the environment and thus included into the tropic chains of biological cycling, "the radionuclides became the source of contamination of environmental sources (soil, water, agricultural products, forests), the consumption of which, or contact with which, led to irradiation of humans" (Alexakhin *et al.* 2007: 418). Geoscientist Thomas Feldoff (2018: 3,7,11) states that the highly volatile fission products Cs134, Cs137 and I131 were released in considerable quantities from the nuclear reactors at Fukushima, transported in the atmosphere and were traceable several thousands of kilometers away – it is calculated that 81 percent of radioactive precipitation fell over the Pacific Ocean.

In the two disasters under discussion the most dangerous of the radionuclides released were plutonium-241 and Caesium-137. The former has by now passed its half-life of 15 years into Americium-241, which decays after 430 years; Cs137 is a long-term source of radiation with a half-life of 30 years and has decayed into relatively harmless Barium-137. "The time period during which 50% of radionuclide is lost or removed from an ecosystem, a vegetation or a particular plant species by both physical and biological mechanisms, is known as 'effective half-life' [Teff], This depends on factors such as physical half-life, biotic and abiotic removal processes, growth rate of the vegetation and latitude (climate). It can be different for various vegetation types" (Oolbekkink and Kuyper 1998:3). In a longitudinal study conducted by Lazjuk *et al.* (1998: 26-32) in Belarus following the ChNRP accident increased frequency of congenital malformations (to humans), such as anencephaly, severe spina bifida cystica, cleft lips, polydactyly, reduction limb defects leading to disability, esophageal atresia, anorectal atresia, Down's syndrome and multiple formations were found in areas contaminated by Cs137. It follows that animals suffer a range of congenital malformations due to the same type of radionuclide exposure. The following section discusses what goes on in restricted zones – not all research findings are negative and research extends beyond animal species alone.

What goes on in the restricted zones of Chernobyl and Fukushima?

In a rather sensational article "Animals rule Chernobyl three decades after nuclear disaster", Wendle (2016) describes how the Przewalski horse nearly went extinct but how the horse's population has been increasing and even thriving (figure 3). This was made possible by introducing the species into the area around Chernobyl in 1998, as well as into other reserves worldwide. A key factor to the success of this project was that humans were restricted from those areas.[20] Not only near-extinct horses, but also birds, bison, moose, deer, beaver, badger, raccoon dogs, red foxes, owls, in addition to more exotic species such as wolves, brown bear and lynx found refuge and are seemingly thriving in that post-nuclear environment. This has been confirmed by eye-witness accounts (and counts) and camera traps documenting animal activity during a five-week survey.

Figure 3
The near-extinct Przewalski horse
(retrieved from the public domain https://en.wikipedia.org/wiki/Przewalski%27s_horse#/media/ File:Przewalskis_horse_02.jpg).

In a study conducted around the Fukushima disaster area Lyons *et al.* (2020: 127-134) assessed the distribution, abundance and activity patterns of diverse vertebrate wildlife species. Those researchers did not capture animals to quantify any biological effects resulting from radiation exposure but state that detection of radiation effects at the molecular level would be expected – their data revealed that "an abundant and diverse community of wildlife exists in the Fukushima Restricted Zone (FRZ), providing evidence of the natural rewilding of the landscape despite the presence of pervasive radiological contamination sufficient to prohibit human residence" (Lyons *et al.* (2020: 131).[21] Mousseau and Möller (2014: 704-8) report more realistically on a number of animal species in both restricted zones. For example, in the Chernobyl Restricted Zone (CRZ) the mutation rates for animals are noteworthy – an example of DNA mutation is a fawn born in the CRZ depicted in figure 4. The mutation rate for birds is 2- to 10-fold higher than the control populations in Ukraine and Italy; "partial albinism" is found in birds and mammals; abnormal sperm in swallows was ten times higher than in control areas; and abnormality rates were correlated with reduced levels of antioxidants in the blood, liver and eggs of birds (antioxidants play a significant role in protecting DNA as a result of exposure to radionuclides). In the CRZ visible tumour rates in birds were in excess of 15/1000 birds – far higher than control groups; cataract expression was higher than control groups; reduced brain sizes in birds were detected; unusual feather shapes and sizes; abnormal growth formations on feet and beaks; invertebrate groups such as grasshoppers, dragonflies, bees and spiders had significantly reduced population sizes (Mousseau and Moller 2014:707). In the FRZ not as much research has been conducted, but butterflies had increased mutation rates but also increased in numbers; and birds had increasing albinism between 2012, 2013 and 2014. Mousseau and Moller (2014:708) state that recent advances [in research] suggest "many small and large effects on biological systems from molecules to ecosystems that will likely influence ecosystem form and function for decades to come".

Figure 4
Fawn born in restricted zone
(retrieved from the public domain https://www.youtube.com/watch?v=1uQLsDrs-74).

Taking into account that background radiation occurs naturally, it is important to note that there are environments with high radiation due to anthropogenic activities in which fungi seem to thrive. Early life forms must have had considerable radiation resistance considering that life emerged on Earth during a time when there was much higher background radiation than the present. It is interesting to note that fungi respond differently to that of other life forms. Radiation from a passing star called Nemesis might have contributed to extinction events when the Earth lost its shield against cosmic radiation and many species (animal and plant) died out. Large amounts of melanised fungal spores have been found in deposits dating back to the Cretaceous period, indicating that melanised fungi are highly radioresistant when subjected to high doses of ionizing radiation. Melanised fungi are found in areas with naturally occurring high radiation levels such as Arctic and Antarctic regions as well as the "Evolution Canyon" in Israel (Dadachova and Casadevall 2008: 525).[22]

A mere five years after the Chernobyl nuclear event cable passages, wall surfaces and ceilings of the reactor buildings began to be covered by fungi rich in melanin,[23] the same element that protects human skin from ultraviolet radiation of the sun. Melanin, which is known to absorb light and even dissipate ultraviolet radiation, enables the fungi to absorb high amounts of energy in ionizing radiation, converting it for its own propagation, similar to how plants utilize chlorophyll during photosynthesis. According to Pomeroy (2020), whilst researchers were remotely piloting robots inside the Chernobyl Nuclear Power Plant they spotted pitch black fungi growing on the walls of the decimated No. 4 nuclear reactor and even apparently seemed to be breaking down radioactive graphite from the core itself. What's more, the fungi seemed to be growing towards sources of radiation, as if the microbes were attracted to them. *Cryptococcus neoformans* is an example of a fungus that occurs at ChNRP that thrives on radionuclides (figure 5).

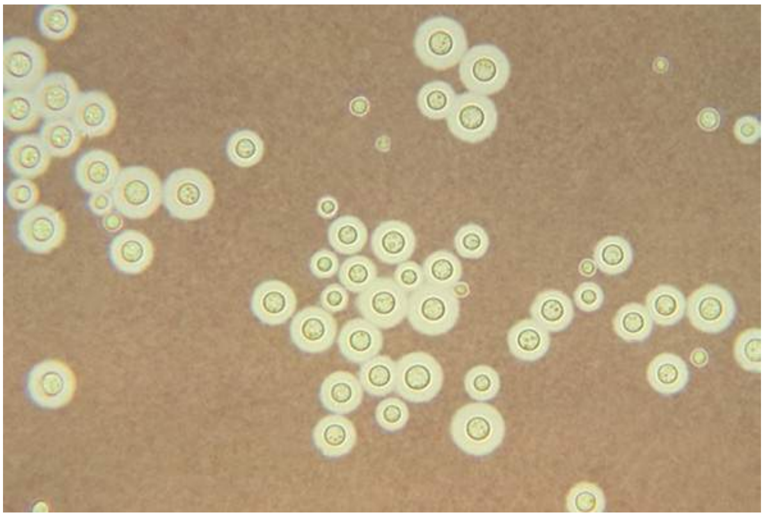

Figure 5
Cryptococcus neoformans
(retrieved from the public domain https://upload.wikimedia.org/wikipedia/commons/6/6f/Cryptococcus_neoformans_using_a_light_India_ink_staining_preparation_PHIL_3771_lores.jpg).

Dighton, Tugay and Zhdanova (2008: 116) explain that ionizing radiation causes genetic alteration in cells and induces cell repair mechanisms. In this process melanin plays a part in providing radioresistance and might also direct fungi to sources of radioactivity. This seems to be borne out by Zhdanova et al. (2000: 1425), who state that the annual dose of radiation received by these fungi is at least ten times the natural background radiation experienced in most places in the world and add that there may be a correlation with their ability to tolerate such high levels of radiation, not only to survive but to grow actively for lengthy periods of time.

Melanin pigments are represented in all biological kingdoms, suggesting that these compounds emerged early in the course of evolution. It is interesting to note that melanins are complex polymers with a variety of properties that can be made enzymatically from relatively simple precursors. “A remarkable aspect of melanins is their ability to absorb all types of electromagnetic radiation that endows them with the capacity for both energy transduction and shielding. The findings of melanized organisms in high radiation environments such as the damaged reactor at Chernobyl, the space station, Antarctic mountains, and reactor cooling water combined with phenomenon of ‘radiotropism’ raises the tantalizing possibility that melanins have functions analogous to other energy harvesting pigments such as chlorophylls” (Dadachova and Casadevall 2008:532). Gerard Oolbekkink and Thomas Kuyper (1989: 3) report that in the weeks after the accident at Chernobyl most attention was directed at the short-living isotopes such as I131; I132; Te132 and Cs134 since those posed direct danger to humans. Those elements have short half-lives and have thus lost their dangerous radioactive nuclides. Currently only Cs137 poses a risk, since the half-life thereof is just over 30 years. Fungi take up the caesiums from the substrate upon which they grow – thus a translocation of Cs134 and/or Cs137 from the substrate layer via the ectomycorrhizal roots to the crown of the fungi. “Mycorrhizal fungi thus participate in the cycling of Cs-134/137 in ecosystems” (Oolbekkink and Kuyper 1989: 5).[24]

Few artists or photographers have had the opportunity to visit restricted zones related to post-nuclear environments. Mara Miller (2017:58), in referring to Japanese artists in all media who often bring to their cutting-edge work the antique and archaic, states that events such as “the atomic bombings, world wars, modernization, not to mention more recent situations such as global warming, nuclear accidents and horrific natural disasters, require new approaches. They do, and they get them.” Whether driven by religion, spirituality, curiosity or moved by the unexpected occurrences witnessed and recorded in such unusual situations, post-nuclear environments have elicited art that does not necessarily place human beings at its centre. Post-nuclear non-anthropocentric art[25] is discussed in the following section.

Post-nuclear art

Due to the abstract and invisible danger of radioactivity, it remains an emotionally charged matter. Yet, artists who are thematically linked to post-nuclear environments seemingly understand the phenomenon and often collaborate in an interdisciplinary manner. Feldhoff (2018: 13) suggests that citizen science has grown in Japan due to online platforms such as Safecast[26] – a project developed by Japanese citizens whereby they can measure, collect and publish data on radiation exposure (independent of official statements and boasting political neutrality). The result is that such a platform has promoted explorative learning and knowledge about radiation and radioactivity. In analyzing traditional and new media coverage of nuclear accidents and radiation, Sharon Friedman (2011: 55-65) compares events at Three Mile Island, Chernobyl and Fukushima and the role that active citizen participation played in the latter. This was due to the Internet, activity in blogs on Facebook, Twitter and YouTube. Friedman reports that around four months after the Fukushima accident commenced, there were respectively 73,700,000 and 22,400,000 results for the search terms “Fukushima” and “Fukushima and radiation”.[27]

Miller (2017: 58), referring to post-nuclear Japanese arts and aesthetics, suggests that artists utilize processes “that are often extremely inconvenient, even physically painful, and that frequently require painstaking research and experimentation”. As mentioned previously, radiation is only perceptible with Geiger counters or other devices such as isotope identifiers, which makes it difficult to comprehend, let alone represent in visual culture. Amandine Davre (2019: 2) sums up the phenomenon aptly: "We are facing a new meaning of visibility, one in what threatens us cannot itself be seen; the radioactive particles remain invisible, incommensurable, and incalculable[…]. They are abstract entities; only their economic, political, ecological, and medical impacts might be perceived." Understandably, the first reports and images after the Fukushima disaster were of visible destruction as a result of the triple disaster – radioactivity per se thus remained obscure in visual culture, although its effects were made public. A seemingly new artistic trend has emerged – "post-Fukushima art" (Davre 2019:3).

Post-Fukushima art responses have had different foci – initially some were critical of the management of the atomic events, others followed with metaphorical and anthropological interpretations. The most controversial of political reactions showed artists illegally in the forbidden zone, facing the Fukushima power plant and holding aloft Japanese flags in a configuration depicting the nuclear symbol (figure 6).

Figure 6
***Chim↑Pom, Real Times*, from the series Real Times, 2011, video, 11 min., 11 sec., (retrieved from the public domain http://chimpon.jp/project/real-times.html).**

This was part of the curatorial collective *Don't follow the wind* which opened in March 2015 in Fukushima and is situated inside structures in the radioactive, evacuated area surrounding the power plant. Because radionuclides are largely driven by wind (from source), the title of the collective infers consciousness of the invisibility of the nuclear threat. This exhibition is inaccessible and will remain invisible to the public at large for years or even decades. Twelve artists including Ai Weiwei, Chim Pom, Grand Guignol, Franco Mattes and others, collaborated.

Yet another exhibition to commemorate the Fukushima disaster is *Catastrophe and the Power of Art* at the Mori Art Museum in Tokyo from October 2018 until January 2019. Artists such as Ai Weiwei, Hirakawa Kota and Shiva Ahmadi participated. Gabrielle Decamous (2019) reports that the show commemorates the Fukushima earthquake, tsunami and nuclear accident. It is interesting to note that practically all of the artworks displayed have a human bias, others serving as metaphors about the interaction between art and science as well as serving as politically committed messages. An example is Ai Weiwei's work in which he shows that often large-scale catastrophes are prone to be forgotten, or are orchestrated to be forgotten by authorities. *Odyssey* (2016-19) depicts endless struggles between the powerful and the powerless. I would like to interpret this theme as the struggle between the powerless (or insignificant) species against the powerful human (species).

Figure 7
***Odyssey* by Ai Weiwei at Mori Art Museum, Tokyo**
(retrieved from the public domain 13 September 2020 http:// www.widewalls.com).

Miller (2017: 60-1) holds that there are often religious values underlying Japanese art that desire to connect with ancestors in honouring those, or seeking nurturance from them. This, she maintains, is strengthened by the Japanese view that arts do not only afford aesthetic pleasure, but contribute to spiritual development and to cognition. Not all trauma is intended to be overcome – in which case art must not serve as consolation – consolation must be refused, alongside transcendence, where "closure" is not necessarily the goal. The concept of impermanence is germane to Buddhism. Miller (2017: 65) refers to the poignancy of things, "an awareness of evanescent beauty, heavily infused with Buddhist sensibility of transience. Impermanence is fundamental to Buddhism, but the primary religious insight stemming from it is that impermanence produces suffering".

The work by Takashi Murakami entitled *500 Arhats* (or enlightened followers of Buddha) is a metaphorical representation (figures 7 and 8). It was exhibited at the Mori Art Museum in 2016 (first unveiled in Doha in 2012). It is a large work measuring 302 X 10,000 cm and is acrylic paint on board. It was created as a token of gratitude to the nation of Quatar which was one of the first countries to offer assistance in the wake of the Fukushima disaster. Upon closer inspection, the creatures and characters depicted are executed in the "manga" style, making it accessible to a wide audience, including children.

Figure 8
***500 Arhats* by Takashi Murakami**
(retrieved from the public domain 13 September 2020 http:// www.widewalls.com).

Figure 9
Detail: *500 Arhats* by Takashi Murakami Photo credit: Mori Museum & Magic Pony
(retrieved from the public domain 13 September 2020 http:// www.widewalls.com).

Non-anthropocentric art that makes the invisible visible

Art photographer Masamichi Kagaya in collaboration with biologist Satoshi Mori, employ radiographic imaging. Their work displays a strong interest in fauna and flora and the effect that radiation has exerted on those (figures 10 and 11). The artist and biologist traveled repeatedly to Fukushima to study and collect animals, plants and everyday objects which had been exposed to radiation during the triple disaster of 2011. Davre (2019: 4) explains that Kagaya measured the radioactivity of an artefact using a Geiger counter after which he put the contaminated object on an imaging plate and locked it in a dark box. The imaging plate would then be activated. Their work uses autoradiography (explained below) to visualize the radioactive substances present in the collected samples. Rather than relying on radioactivity measurements as evidence of its presence, they offer visual evidence of radioactivity, where light captured on the film is proportional to the radioactivity integrated with the specimen. Their work makes visible the invisible and is strongly evocative of transience and deterioration. The effect of the radiographic snake image on the left of figure 10, compared to the "real" snake on the right, is ghostly, magical and unlike the real dead snake, lives on. The two images, viewed side by side, are rather difficult to reconcile as being the selfsame subject.

Figure 10
Autoradiograph – Works of a Nuclear God **by Masamichi Kagaya and Satoshi Mori, 2012**
(retrieved from the public domain 29 June 2020 https://www.fisheyemagazine.fr/en/discoveries/beaute-radioactive/).

Autoradiography is an imaging technique that uses sources that are radioactive within the exposed artefact. Capturing photographic images autoradiographically involves using, for example, a flexible silver halide (AgX)[28] film (invariably cellulose acetate) which is ionized by the radiation emitted from radioisotopes. This forms silver positive ions (Ag^+) which are then reduced and converted to metallic Ag by a developer reagent which precipitates within the gelatin emulsion of the X-ray film, only stopped by a neutralizing agent, or "stop bath" (the stop bath neutralizes the alkaline developer, in effect preventing any further development of the image. A fixative solution stabilises the image by removing any unexposed silver halides). What is interesting is that each AgX molecule is individually encapsulated in the gelatin which acts as an independent detector of radioactive decay from the chosen radioactive item, as can be seen in Figure 10. Once radioactive particles hit the gelatin emulsion, AgX is reduced resulting in the production of insoluble silver crystals.[29] What is visible in Figures 10 and 11 is the result of objects which were in contact with a coated X-ray film after which it generates a hidden (or latent image) which corresponds to the radioactivity inherent to the sample. The next step is to make the "imprint" visible by submerging it in a developing agent that converts the silver crystals into metallic silver and simultaneously darkens the gelatin emulsion. Photographers will recognise principles that are similar to analogue dark-room practice.[30]

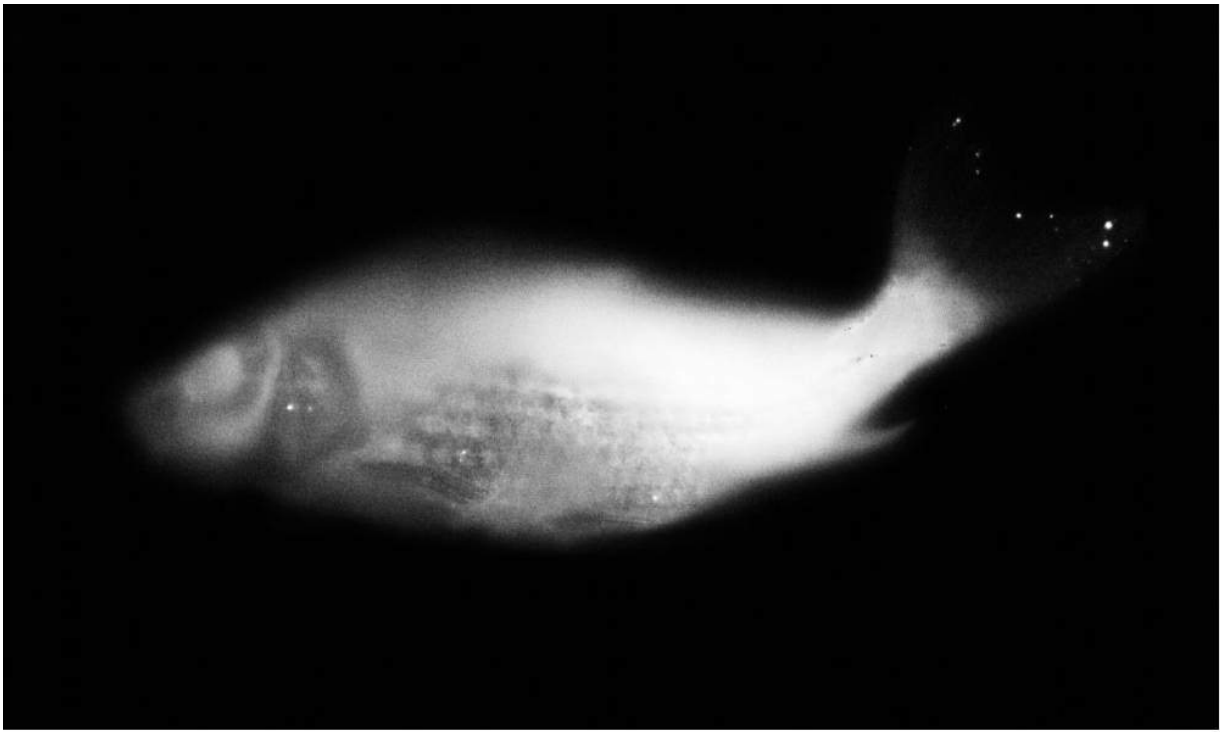

Figure 11
***Autoradiograph – Works of a Nuclear God*, Masamichi Kagaya and Satoshi Mori, 2012.**
(retrieved from the public domain 29 June 2020 https://www.fisheyemagazine.fr/en/discoveries/beaute-radioactive/).

These chimeric images (ironically) reveal the true state of the hidden danger and environmental pollution that resulted in the ecological disaster that occurred at Fukushima. Such works may be deemed "research creation", often interdisciplinary, where the focus of the work of art is not necessarily a finished object for a gallery, "but an intervention in the situation, framed in terms of relational aesthetics – a set of practices that take the social context as their theoretical and practical point of departure" (Clarke 2020: 175). As with the previous snake image, the dead and irradiated fish in figure 11 is difficult to describe – it seems to be floating in space, harbouring a timeless message of something irretrievably lost. As with the fish in figure 11, the irradiated feather featured in figure 12 shapeshifts and resembles a beacon of light or a wand (that might, ironically, harbor defensive or protective qualities) pointing into an ominously dark sky.

Figure 12
***Autoradiograph – Works of a Nuclear God*, Masamichi Kagaya and Satoshi Mori, 2012.**
(retrieved from the public domain 29 June 2020 https://www.quod.lib.umich.edu/t/tapic /x-7977573.0010.104-00000003/1?).

Visual artmaker and filmmaker Shimpei Takeda reveals the invisible disaster that overcame Fukushima, near to which his family resides, in surprising and unexpected ways. Takeda is familiar with analogue photographic techniques in which a photograph is created by light – in figure13 the artist created silver gelatin prints of falling rain, snow and ice in a series entitled *Glaze.* As explained previously, radiation such as gamma rays and invisible light inherently work in a similar way as does light-sensitive photographic material in which silver halide darkens when exposed to radiation. Davre (2019:12) explains that whereas a photogram needs around six minutes of light exposure a radiogram might require several weeks to a few months to capture an imprint, depending on the radiation activity.

Figure 13
Shimpei Takeda, *Glaze*, 2012.
(retrieved from the public domain http://www.shimpeitakeda.com).

Figure 14
Shimpei Takeda, *Trace # 7*, 2012, 50.8 x 61 cm., gelatin silver print,
(retrieved from the public domain http://www.shimpeitakeda.com).

Takeda's ongoing project *Trace: Cameraless records of radioactive contamination* consists of cameraless records of radioactive contamination in which radiation in the contaminated soil exposes photographic materials as direct and physical documentation of the disaster. The work exposes (and evidences) the essence of radiation fallout to the viewer in a novel and fascinating way. Akin to the work of Masamichi Kagaya and Satoshi Mori, Takeda's makes visible the invisible. *Trace #7* (figure 14) is soil from the Nihonmatsu Castle, a gelatin silver print (50.8 cm X 61cm).

Anthropologist and artist Jennifer Clarke (2020: 173) notes that initially it was viewed as distasteful for foreigners to engage in research about Fukushima but seemingly that attitude has softened. Clarke has an ongoing relationship with an art community in the Fukushima area and has created a series of artworks *Invisible Matters* which have as an underlying theme the Japanese concept of *gaman suru* which translates as "ongoing suffering".[31] In this series, Clarke produced site-specific installations which were open to the public where she "metaphorically and literally raised issues, including the fraught matter of radiation exposure, in a number of ways. For example, the key component of *REC.3.11*, the first Invisible Matters exhibition [a collaborative event to commemorate the fourth anniversary of the disaster], was the making of a series of cyanotype prints exposed in natural light" (Clarke 2020: 175). In the series Clarke used Prussian blue (ferric ferrocyanide, a solution of cyanotypes made with ferric ammonium citrate and potassium ferricyanide) to make prints, after learning that this chemical compound was used in Britain after the Chernobyl disaster, when scientists were experimenting with ways to absorb radioactivity in the soil, by inhibiting the uptake of Cs137. In figure 15 the artist used a galamanthus root as her subject matter – this cyantype is printed on handmade paper.

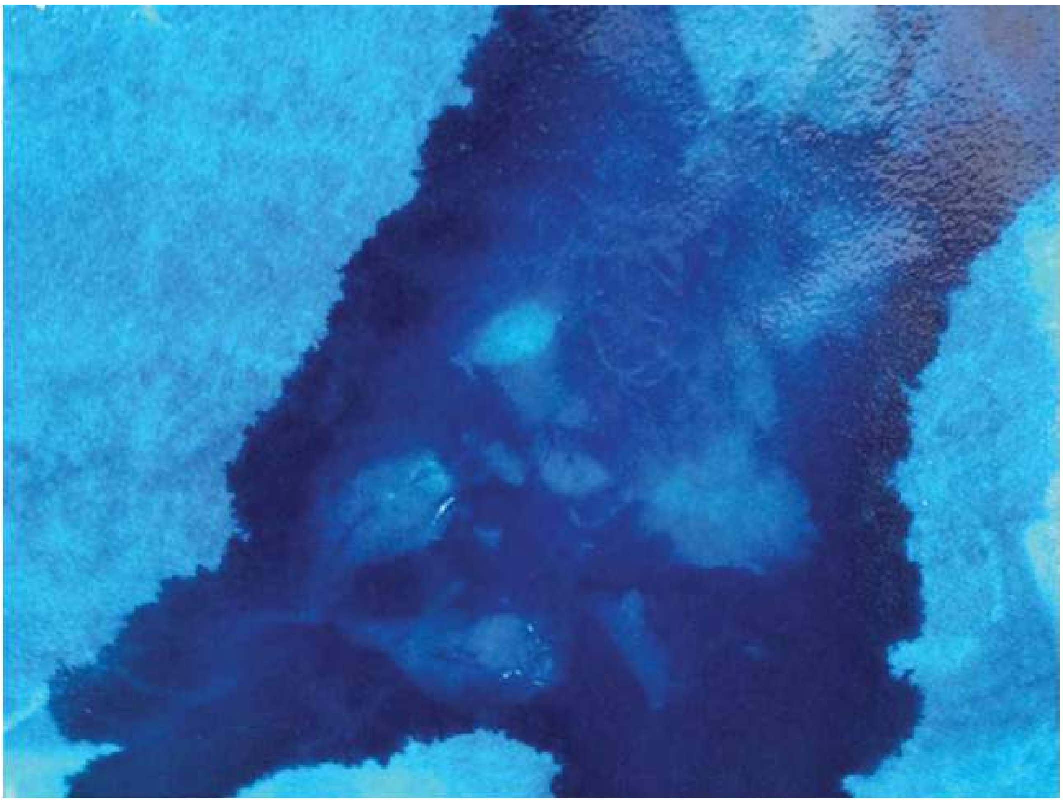

Figure 15
Jennifer Clarke, *Moly,* 2015,
60 cm x 60 cm (Source: Clarke 2020: 176).

During 2013 Japanese artist Yoi Kawakubo started visiting and photographing the FRZ regularly during a one-year artist residency at Tokyo Arts and Space. He then buried the film in situ, retrieving the film some three months later and found that the film had reacted to the radioactive particles which were present in the soil. Similar to the work of Takeda, the soil had in fact printed the film. Davre (2019: 8) explains that Kawakubo then tested time exposures and the silver halide film and started burying 8 x 10 inch silver halide film in holders, (without prior images), where radioactivity levels were high. Some six months later he retrieved the film and printed the captured image in an enlarged format. Figure 16, in which colour sheet film was used (the notches at the top left-hand side of the image indicate such) is one of a series titled *If the Radiance of a Thousand Suns were to Burst at Once Into the Skies* which relates to words used by Robert Oppenheimer (who led the American Manhattan Project).[32] Kawakubo created the series to raise awareness and to caution humans against the dangers of "playing God" and in so doing change the course of human history. "Playing God" could be deemed the epitome of anthropocentrism. Clearly, this is not a human history alone, any longer.

Figure 16
Yoi Kawakubo, *If the Radiance of a Thousand Suns were to Burst at Once into the Sky I*, 2014, pigment print of radiation-exposed colour film, 101 x 81 cm (retrieved from the public domain https://www.yoikawakubo.com/thousand-suns).

I posit that catastrophes can be expressed powerfully from a non-anthropocentric position. Artworks selected for this article, each a product of the same nuclear catastrophe, create a context that touches the sublime – a small, irradiated fish frozen in time, forever emitting and swimming in a toxic light – a plant root glowing and growing with malevolent life – an abstract "painting" of irradiated soil reminiscent of cosmic catastrophes. Kawakubo's *If the Radiance of a Thousand Suns were to Burst at Once Into the Skies IV* (figure 17), produced five years after the first in the series, attests to how the artist has mastered his chosen medium. As with the earlier work, in its simplicity it is stripped of any detractors that might lean towards the pragmatic – a key factor that positions an artwork as eliciting an aesthetic experience (and creating a relationship) with the viewer is when objects lose their everyday meaning and transcend into a novel symbolic reality.[33] The incidental and serendipitous manner that radiation is made manifest in Kawakubo's later work – caustically biting, pitting and chewing its way into some another dimension, reminds of as-yet-unformed cosmic black holes that will someday consume everything in their ambit. This work is testament of a beautiful manifestation of the terrible, where, in a manner of speaking, the terrible has in partnership with the artist, created the artwork.

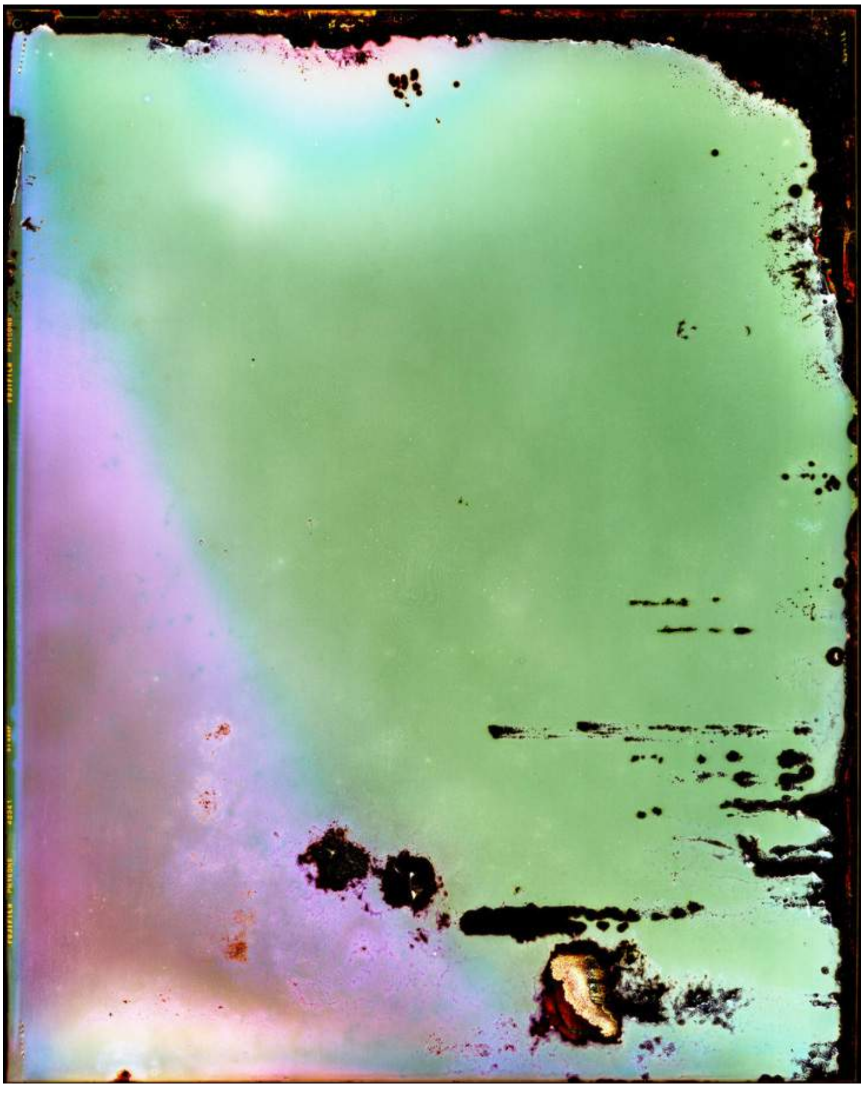

Figure 17
Yoi Kawakubo, *If the Radiance of a Thousand Suns were to Burst at Once into the Sky IV*, 2019, pigment print of radiation-exposed colour film, 101 x 81 cm (retrieved from the public domain https://www.yoikawakubo.com/thousand-suns).

“At its root, the sublime refers to an experience in which words fail, when we find ourselves beyond the limits of reason. I also came to understand this in a singular moment” (Clarke 2020: 178). The moment Clarke was referring to was when, in 2014 (three years after the disaster), she drove through the evacuated zone around the Fukushima Daiichi nuclear power plant and took in her first sight of the destruction which she describes as “a terrible beauty” where a bridge had acted as a barrier for the tsunami. When apocalyptic images are seen from a safe distance we experience the sublime – “It is this distance that permits the potential of a sublime experience, the beauty in the terrible” (Clarke 2020: 178). Takeda and Kawakubo’s work seem like abstractions of a terrible beauty, at a distance. The converse regarding distance is also true – physical environments affect us in special ways since they tend to carry strong messages about the possibilities of our physical, social and mental survival and rather than distancing us, require us to be engaged. In this way art has the capability of transmitting truth and “one might well consider some art types of cognitive prostheses” (Miller 2017:70-2).

Conclusion

This article explains why an anthropocentric view, placing humans at the centre of the universe, is not sustainable. It also cautions against using terms such as novel for failed or post-nuclear environments as a result of anthropogenic activities gone wrong. It further suggests that, to visually express the enormity and the horror of the disasters that occurred at Fukushima and Chernobyl in visual culture, is complex and dependent on the chosen bias. The bias of this article is in favour of all species, especially those endangered. It is difficult to be inclusive of all species or empathic to what is endangered when the root cause of catastrophe is invisible and human trauma is positioned at its centre. Roman Rosenbaum (2018: 170), who refers to a post-truth world where reliable information is almost impossible to obtain, suggests that the arts may sustainably serve as treatment for the painful process of working through trauma. In reviewing essays on Fukushima and the arts, Rosenbaum justifies why art can play a role when facing a human catastrophe the size of Fukushima by borrowing from a Brechtian tradition – that “art becomes […] neither a mirror held up to reality nor a hammer with which to shape it. Art, instead, reveals what is beneath the surface, thus becoming a “Geiger counter for the truth”. This is especially apt with regard to the art discussed in this article.

Artists featured in this article seem to have found (and I appropriate Clarke’s words mentioned previously) beauty in the terrible – in this case a terrible truth. Miller (2017: 69) suggests that beauty, other than compelling our attention, “mirrors or symbolically represents both the inner significance of the subject matter and the forms of action and attention required for its comprehension”. In affording reverence to mundane things such as a dead snake or a sprinkling of soil – things that harbour a horrific invisibility – these artists succeed in making art that surpasses the pragmatic and becomes symbolic of a wealth of possibilities in which human existence and natural life are intimately connected.

Acknowledgement

I owe a debt of gratitude to Dawie Malan, a longstanding friend and subject librarian at the University of South Africa, who enthusiastically assisted me in finding the sources that enabled me to complete this research.

Notes

1 Webster's unabridged dictionary, 2001:88.

2 The Holocene is claimed to be distinct from other interglacial periods due to the near-global presence of modern humans (Braje and Erlandson 2014).

3 Steffen, Grinevald, Crutzen and McNeill (2011).

4 Steffen *et al.* (2011).

5 Mikkelson (2019: 136-7) explains that the closely aligned movements of sentientism and biocentrism run the risk of failure since they rely on moral individualism in which they endorse either of two extreme positions - utter human domination of the planet, or human extinction. Sentientists hold that all sentient animals have intrinsic value. But they deny a further claim that biocentrists assert: that non-animal organisms, such as plants and fungi, also have moral significance for their own sake (Varner, 2001; Attfield, 2013).

6 Hiroshima is located in a flat delta, experiencing greater human loss than Nagasaki, located in a valley, enclosed by mountain ridges which shielded the city to some extent (retrieved from http://www.aasc.ucla.edu/cab/200708230009.html/).

7 28 people initially died and more than 100 were injured but accurate numbers remain highly debated (Blakemore 2019).

8 Clarke (2020:188) explains: "An 'incident' is at level 2 of the International Nuclear and Radiological Event Scale (INES), as determined by the International Atomic Energy Agency, from 0 to 7. An 'accident' is level 4 or 5, depending on the wider consequences. Fukushima was a 5. The atomic bombings of Hiroshima and Nagasaki were 7"; the Fukushima accident left 18,000 people dead and thousands more injured. 340,000 people were displaced from their homes. Hundreds and thousands of buildings were destroyed (Clarke 2020: 172); there are various accounts of the height of the Fukushima tsunami - 39 meters seem the norm (Reid, 2019).

9 Hobbs *et al.* (2006: 3) offer the following in terms of such thresholds: "In principle, there are two types of threshold that ecosystems can cross. *Biotic thresholds* are created by dispersal barriers and result in unusual combinations of species and functional groups arise. *Abiotic thresholds* result from severely changed abiotic conditions such as, for example, soil erosion on clearcut or overgrazed slopes, or different hydrological conditions due to changed evapotranspiration."

10 I have taken cognisance that nuclear accidents generate problems other than ecological ones – for example technological, medical, economic, agricultural and social issues are important when overcoming consequences of such accidents (Alexakhin *et al.* 2007: 418).

11 It is beyond the scope of this article to go into too much detail of the permutations that may occur.

12 Lithosphere is the solid outer layer of the Earth above the asthenosphere, consisting of the crust and upper mantle; asthenosphere is a weak zone in the upper part of the Earth's mantle where rock can be deformed in response to stress, resulting in movement of the overlying crust (Encarta Concise English Dictionary, 2001: 842, 81).

13 Von Gunten and Benes (1995: 10).

14 Von Gunten and Benes (1995: 2).

15 https://www2.lbl.gov/abc/wallchart/chapters/12/2.html.

16 https://hps.org.publicinformation/ate/q10748.html.

17 https://www.atomicarchive.com/science/effects/basic-effects.html.

18 https://www.atomicarchive.com/science/effects/basic-effects.html.

19 Von Gunten and Benes (1995); Oolbekkink and Kuyper (1989); Lazjuk *et al.* (1998); Alexakhin *et al.* (2007).

20 Exclusion zones in Ukraine and Belarus caused by the Chernobyl nuclear disaster equate to some 1,600 square miles.

21 The three areas studied are referred to as Fukushima Evacuation Zone or Fukushima Exclusion Zone (FEZ) (Lyons *et al.* 2020: 128); recorded in the FEZ representing different

levels of human activity abundance was found inter alia wild boar, hare, civet, raccoon, green pheasant, macaque, marten, squirrel, fox, raccoon dog, badger, copper pheasant and serow (Lyons *et al.* 2020: 131).

22 Melanin pigments are found in all biological kingdoms, suggesting that these compounds are ancient molecules that emerged early in the course of evolution. A remarkable aspect of melanins is their ability to absorb all types of electromagnetic radiation that endows them with the capacity for both energy transduction and shielding (Dadachova and Casadevall 2008: 530).

23 The ratio of light- and dark-pigmented species indicated that melanin-containing species predominated at all levels of radiation (Zhdanova *et al.* 2000: 1425).

24 "Ectomycorrhiza (ECM) is a symbiotic association of fungi with the feeder roots of higher plants in which both the partners are mutually benefitted and indeed the association appears to be significant for the existence of both the partners" (Charya and Garg 2019: 303).

25 I take cognisance that the visual arts include, inter alia, crafts, including film, performing and the literary – in this article the arts referred to are visual arts which include art photography. This does not preclude the possibility that the visual arts may intersect with other arts.

26 https://safecast.jp.

27 There are disadvantages as well as advantages related to massively free information when the accuracy of information is questionable.

28 Silver bromide, chloride, iodide or fluoride can be used (https//conductscience.com/what-is-autoradiography/).

29 https//conductscience.com/what-is-autoradiography/

30 Advanced autoradiographic methods such as positron-emission tomography (PET) and single-photon computerised tomography (SPECT) are used in clinical diagnosis and monitoring of disease. The difference lies in that radiotracers that are suitable for humans use computer algorithms to produce high resolution 4D reconstructions of body parts (https//conductscience.com/what-is-autoradiography/).

31 "Nevertheless, Brian Victoria goes on to argue that *gaman* is intimately related to *ho-ben*, meaning expedience or not telling the whole truth, and directly connects it to radiation: '*gaman* can and has been used to justify the endurance of *human-created* injustice, including exposure to nuclear radiation' " (Clarke 2020 : 177).

32 Whilst testing the H-bomb in July 1945, "Oppenheimer recalled the verse from the Bhagavad-Gita, the Holy text: If the radiance of a thousand suns were to burst into the skies, that would be like the splendour of the Mighty One" (Davre 2019: 9).

33 See Van Heerden, A. 2018. Identifying aesthetic experience. *South African Journal of Art History*, Vol 33(4): 1-12, in which I explain that the aesthetic experience is a combined psychological, neurological and affective phenomenon. Aesthetic experience is not reducible to positive hedonic tone or positive emotions, but is known to occur when objects or events lose their pragmatic or everyday meaning and transcend into a novel symbolic reality.

Works cited

Alexakhin, R.M., Sanzharova, N.I., Fesemko, S.V., Spiridonov, S.I. and Panov, A.V. 2007. Chernobyl Radionuclide distribution, migration, and environmental and agricultural impacts. *Health Physics* 93(5): 418-26.

Attfield R (2013) Biocentrism, *The International Encyclopedia of Ethics,* edited by LaFollette, H. New York: Wiley-Blackwell: 526–34.

Atkins, Harry. 2018. How many people died in the Hiroshima and Nagasaki bombings? Retrieved from www.HistoryHit.com on 9 August 2020.

Bish, Joe. 2020. Many other curves need flattening: Population is one. Population Media Centre. Retrieved from https://info.populationmedia.org on 26 March 2020: 1-9.

Blakemore, Erin. 2019. The Chernobyl disaster: What happened, and the long-term impacts. Retrieved from www.nationalgeographic.com.

Braje, T.J. and Erlandson, J.M. 2014. Looking forward, looking back: humans, anthropogenic change, and the Anthropocene, *Anthropocene* 4: 116–21.

Charya, Lakshangy S. and Garg, Sandeep. 2019. Advances in methods and practices of ectomycorrhizal research, *Advances in Biological Science Research.* Retrieved from https://doi.org/10.1016/B978-0-12-817497-5.00019-7: 303-25.

Clarke, Jennifer. 2020. Apocalyptic sublimes and the recalibration of distance: doing art-anthropology in post-disaster Japan, *Exploring Materiality and Connectivity in Anthropology and Beyond,* edited by Schorch, Phillip, Saxer, Martin,and Elders, Marlen. University College Press: London: 172-190.

Corlett, Richard, T. 2014. The Anthropocene concept in ecology and conservation, *Trends in Ecology and Evolution* (Jan 2015), 30(1): 36 – 41.

Dadachova, Ekaterina and Casadevalle, Arturo. 2008. Ionizing radiation: how fungi cope, adapt, and exploit with help of melanin, *Current opinion in Microbiology*, 11: 525-31.

Davre, Amandine. 2019. Revealing the Radioactive Contamination after Fukushima in Japanese Photography, *Writing Photo Histories: Trans Asia Photography Review* 10(1). Retrieved from http:/ /hdl.handle.net/2027/spo.7977573.0010.104.

Decamous, Gabrielle. 2019. “Insignificant” lives and the power of the arts after Fukushima, *Afterimage* 46(3): 15-24.

Dighton, John, Tugay, Tatyana and Zhdanova, Nelli. 2008. Fungi and ionizing radiation from radionuclides, *FEMS Microbiology Letters* 281: 109-120.

Feldhoff, Thomas. 2018. Visual representations of radiation risk and the question of public (mis)trust in post-Fukushima Japan, *Societies* 8(2), 32: 1-20.

Friedman, Sharon M. 2011. Three Mile Island, Chernobyl and Fukushima: An analysis of traditional and new media and radiation, *Bulletin of the Atomic Scientists* 67(5): 55-65.

Glickson, A. 2013. Fire and human evolution: the deep-time blueprints of the Anthropocene, *Anthropocene* 3: 89-92.

Hobbs, Richard J., Arico, Salvatore, Aronson, James, Baron, Jill, S., Bridgewater, Peter, Cramer, Viki, A., Epstein, Paul, R., Ewel, John, J., Klink, Carlos, A., Lugo, Ariel, E., Norton, David, Ojima, Dennis, Rishardson, David, M., Sanderson, Eric, W., Valladares, Fernando, Vilà, Regino Zamora, Zobel, Martin. 2006. Novel ecosysytems: theoretical and management aspects of the new ecological world, *Global Ecology and Biogeography 15.* Retrieved from www.blackwellpublishing.com/geb DOI: 10.1111/j.1466-822x.2006.00212.x: 1-7.

Hobbs, R.J., Higgs, E.S., Hall, C.M. 2013. Defining novel ecosystems, *Novel Ecosystems: Intervening in the New Ecological World Order*, edited by Hobbs, R.J., Higgs, E.S. and Hall, C.M.

United Kingdom: Wiley and Sons: 58-60.

Richard J. Hobbs, Eric S. Higgs, and James A. Harris. 2014.
Novel ecosystems: concept or inconvenient reality? A response to Murcia *et al. Trends in Ecology and Evolution* (1998). Retrieved from http://dx.doi.org/10.1016/j.tree.2014.09.006.

Iovino, Serenella, 2010. Reflections on Local Natures and Global Responsibilities, *Ecocriticism and a Non-anthropocentric Humanism*. Retrieved from https://doi.org/10.1163/9789042028135_004: 29-53.

Lazjuk, Gennady, Satow, Yukio, Nikolaev, Dmitri and Novikova, Irina,.1998. Genetic consequences of the Chernobyl Accident for Belarus Republic, *Gijutsu-to-Ningen* 283: 26-32.

Lyons, Philip C, Okuda, Kei, Hamilton, Matthew T, Hinton, Thomas G, Beasley, James. 2020. Rewildering of Fukushima's human evacuation zone. *Frontiers in Ecology and the Environment* 18(3): 127–134.

Marris, E. 2010. The new normal. *Conservation Magazine* 11(June 4): 13–17.

Marris, Emma, Mascaro, Joseph and Ellis, Erle C. 2013. *Novel Ecosystems: Intervening in the New Ecological World Order*, edited by Richard J. Hobbs, Eric S. Higgs, and Carol M. Hall. USA: John Wiley and Sons: 345 – 9.

Mikkelson, G.M. 2019. Holistic versus individualistic non-anthropocentrism, *The Ecological Citizen.* 2 (2).

Miller, Mara. 2017. Beauty, religion and tradition in post-nuclear Japanese arts and aesthetics, in *Artistic Visions and the Promise of Beauty, Sophia Studies in Cross-cultural Philosophy of Tradition and Culture*, edited by K.M. Higgins *et al.* Switzerland: Springer International Publishing: 57-75.

Mousseau, Timothy, A. and Möller, Anders, P. 2014. Genetic and ecological studies of animals in Chernobyl and Fukushima, *Journal of Heredity* 105(5):704-9.

Oolbekkink, Gerard, T. and Kuyper, Thomas, W., 1989. Radioactive Caesium from Chernobyl in fungi, *The Mycologist* 3: 3-6.

Pomeroy, Ross. 2020. Fungi that 'eat' radiation are growing on the walls of Chernobyl's ruined nuclear reactor, *Real Clear Science* (Feb 4).

Reid, Kathryn. 2019. 2011 Japan earthquake and tsunami: Facts, FAQs and how to help, World Vision Retrieved from www.worldvision.org on May 7 2020.

Rosenbaum, Roman. 2018. Fukushima and the Arts: Negotiating Nuclear Disaster, edited by Barbara Geilhorn and Kristina Iwata-Weickgenannt (review), *Monumenta Nipponica* 73(1): 170-177.

Sekizawa, Ryo, Ichii, Kazuhito and Kondo, Masayuki. 2015. Satellite-based detection of evacuation-induced land cover changes following the Fukushima Daiich nuclear disaster. *Remote Sensing Letters* 6(11). Retrieved from DOI: 10.1080/2150704X.2015.1076207: 824-833.

Steffen, Will, Grinevald, Jacques, Crutzen, Paul. and McNeill, John. 2011. The Anthropocene: conceptual and historical perspectives, *Philosophical Transactions of The Royal Society A*. Retrieved from https://doi.org/10.1098/rsta.2010.0327.

Steffen, Will, Persson, Asa, Deutsch, Lisa, Zalasiewicz, Jan, Williams, Mark, Richardson, Katherine, Crumley, Carole, Crutzen, Paul, Folke, Carl, Gordon, Line, Molina, Mario, Ramanathan, Veerabhadran, Rockström, Johan, Scheffer, Marten, Schellnhuber, Hans, Joachim and Svedin, Uno. 2011. The Anthropocene: From global change to planetary stewardship, *AMBIO* 40(739). Retrieved from https://doi.org/10.1007/s13280-011-0185-x :739-761.

Von Gunten, H.R and Benes, P. 1995. Speciation of Radionuclides in the Environment, *Radiochimica Acta* 69: 1-29.

Varner G. 2001. Sentientism, A *Companion to Environmental Philosophy*, edited by Jamieson D. New York: Wiley-Blackwell: 192–203.

Wendle, John. 2016. Animals rule Chernobyl three decades after nuclear disaster. Retrieved from www.nationalgeographic.com.

Zhdanova, Nelli N., Zakharchenko, Valentina, A., Vember, Valeriya, V., and Nakonechnaya, Lidiya, T. 2000. Fungi from Chernobyl: mycobiota of the inner regions of the containment structures of the damaged nuclear reactor, *Mycological. Research* 104 (12): 1421 – 6.

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