Evolution of Nuclear Environments: From Forbidden Gardens to Nuclear Landscape Monuments

Linda Grisoli
DiAP Dipartimento di Architettura e Progetto, Sapienza Università di Roma, Italia
linda.grisoli@uniroma1.it

Gordon JieXi Goh
RMIT Alumnus and Landscape Architect, North Borneo (Sabah), Malesia
gordon88goh@gmail.com

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Abstract

The dawn of Anthropocene saw the birth of nuclear landscapes (NL): places heavily contaminated by radioactivity, left behind by human interventions. From nuclear weapon production to detonation sites and atomic power plants, unfortunate events had resulted in environmental catastrophes, turning these NLs into forbidden gardens - off-limits frontiers of waste . Human absence promoted NL to metamorphose into post-nuclear landscapes, characterized by a primal image of nature: pristine and spontaneous. It is an unreleased kind of wilderness, a living archive of human ecocides. Later, governmental interventions gradually transformed these sites into Nuclear Landscape Monuments (NLM), making them embodiments of degradation and redemption. The essay investigates the evolution of these nuclear environments and their wild ambivalent nature. It further elucidates the shift in humans' attitudes towards nature, through an atomic narrative: from production and destruction to recovery and reconciliation. The essay also highlights the role of anthropogenic and natural agencies in establishing this intricate co-existing relationship between humans and non-humans.

L'alba dell'Antropocene registrò la nascita dei paesaggi nucleari (NL): luoghi altamente radioattivi, a lungo abbandonati a sé stessi. Dalla produzione di armi nucleari ai siti di detonazione, tragici avvenimenti provocarono catastrofi ambientali, rendendo i NL veri e propri giardini proibiti - frontiere off limits di scorie radioattive. L'assenza dell'uomo favorì la metamorfosi dei NL in paesaggi post-nucleari, caratterizzati da un'immagine primordiale della natura, incontaminata e spontanea. Si delineava un'inedita tipologia di ambiente, un archivio vivente dell'ecocidio umano. In seguito, svariati interventi governativi hanno gradualmente trasformato questi siti in Nuclear Landscape Monuments (NLM), un'incarnazione di degrado e redenzione. Il saggio indaga l'evoluzione di queste ex aree nucleari e la loro natura ambivalente. Inoltre, attraverso la narrazione atomica, chiarisce il cambiamento dell'atteggiamento dell'uomo nei confronti del paesaggio naturale: dalla produzione e distruzione, al recupero e alla riconciliazione. Il saggio evidenzia anche il ruolo delle componenti antropiche e naturali nello stabilire l'intricata relazione di coesistenza tra esseri umani e non umani.

Keywords

Nuclear Landscapes, Anthropocene, Wildness, Evolution, Coexistence.

Paesaggi Nucleari, Antropocene, Selvaticità, Evoluzione, Coesistenza.

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Anthropocene

The discovery of nuclear energy marked a new era for humanity. Nuclear epic officially began in the first forty years of the twentieth century (Sertorio, 2008), with the experiments carried out by a group of scientists under the leadership of Enrico Fermi[1], nicknamed the "Pope of Physics" (Segrè & Hoerlin, 2017). Fermi's pioneering research, together with America's most secret Manhattan Project, changed our world. Nuclear power overtook the geological epochs in which natural processes were the main agencies of change on the Earth's surface, becoming the symbol of a new era, called 'Anthropocene'.

The age of Anthropocene can be perceived as a time-space production created by nuclear power, demarcating a historical age of humans' uprise over other living beings. Sadly, with great power at hand, humans had changed their own living environments, as quoted by Gan in (2017, p. 2), "it is an age where humans are willing to turn things into rubble, destroy atmospheres, sell out companion species in exchange for dreamworlds of progress."

By uncovering the mystery of the atom, man acquired ideologies of control and dominion over the 'other'. From energy generators to military development, despite the different functionalities of these high-tech nuclear inventions, emblems of our darkest achievement in the control of natural forces (Dieterle, 2002).

Nuclear production cycle in the USA, for instance, on the one hand, had protected several areas from the threat of urbanization, while fulfilling considerable energy demands; on the other hand, it resulted in radioactive waste, in addition to catastrophic episodes like Chernobyl and Fukushima incidents, contaminating the entire ecosystems around the regions condemned as 'ecocides victims.'

Nuclear Landscapes

This new era of Anthropocene saw the birth of nuclear landscapes, carrying the physical scars of prolonged military exigencies that sought after nuclear power. The failure and mistakes from international nuclear weapons testing, nuclear energy production and nuclear disasters are now embedded in our environment (Alexis Martin, et al., 2016) and our cultures. Nuclear disasters, defined by Funabashi (2012, p. 65) as "man-made calamities because of technological failures", have caused the death of both people and natural habitats. However, nuclear disasters are not only that of Fukushima and Chernobyl, but all those human errors related to nuclear production which soon present similar collateral effects: what seemed predictable becomes unpredictable and uncontrollable with serious implications on ecology as well as on human health.

Nuclear landscapes are born; vast insalubrious, arid, desolate, remote, and inhospitable areas. Often

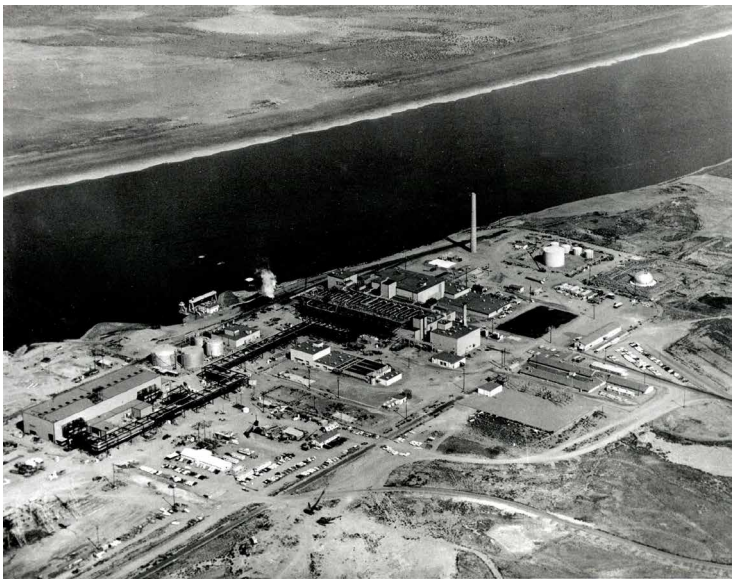

Fig. 1 – The first and only reactor in the United States used for the simultaneous production of electricity and plutonium is located at the AEC's Hanford project near Richland, Washington. The reactor achieved critical on December 31, 1963 (photo: US Department of Energy, 1967)

abandoned, along with toxic debris, but still strictly off-limits. Though fascinating to some, these desolate places are a serious ecological injury. Nuclear eco-cemeteries, as nuclear test sites, like Hanford site (fig. 1), Washington, were nicknamed. The original features of several habitats have been razed. Soils, sediments, and groundwater were affected by nitroaromatic pollution, and refined by-products, while uranium-processing operations resulted in radiological contamination.

These territories are demarcated by the invisible presence of radionuclide, a matter that pertains to agencies and materialities far beyond humans' control. It travels through waters and grounds; gets inside plants and animals; imperceptible to the naked eye even as humans learn to find its traces (Gan, et al., 2017). Radiation is not absent present, radiation is far too present, exceeding the corporeal capacity for self-healing. (Rush-Cooper, 2019).

Forbidden Gardens

The invisible nuclear presence in these territories creates borders that many people are afraid to cross. These radioactive borders were constantly expanding, due to the unending production of nuclear waste, radioactive spillage and the long half-life of radioactive isotopes, contaminating the surrounding area and making them uninhabitable.

Consequently, governments sanctioned these regions as off-limits areas with the objective to contain the contamination and preventing any nuclear radioactivity from escaping. At the same time, hindering people from entering. They had become places devoid of humans, a no-man's land – *Terra Nullius.*

A timely large-scale remediation process of the so-called "gardens of apocalypse"[2] began. Some of them were enlisted as national wildlife reserves, others became 'involuntary parks', a term coined by the environmentalist Sterling to depict previously nuclear-contaminated exclusion zones which had been allowed to revert to a wild natural state.

In the United States, enormous amounts of radioactive and chemically hazardous wastes produced while making plutonium (Department of Energy, 2007) necessitated urgent containment. The U.S.

Fig. 2 – Grout manufactured at the Chemical Stabilization and Solidification Plant is piped directly on and around the waste in the Disposal Cell (photo: Energy Government, 10 May 2002).

Environmental Protection Agency (EPA) and especially the U.S. Department of Energy (DOE) had committed to achieving clean-up standards to make sites safe again for human health and the environment. Both Hanford Site in Washington, and Weldon Spring Site in Missouri were among iconic examples of post-trauma remediation.

The primary mission at Hanford has changed from weapons production to large-scale environmental remediation. Massive projects started to remove the site's-built infrastructures and dispose the 56 million gallons of radioactive waste currently buried beneath the surface of the site. Remediation is slated to be completed in the coming decade while efforts to dispose of the radioactive waste will continue for the next forty to fifty years. The reactor buildings themselves will remain entombed in concrete in the stark Hanford desert for 100 years as their radioactive cores decay.

As for Weldon Spring site, remedial activities concluded with the completion of the waste Disposal Cell – a 41-acre engineered structure (fig.2) designed to contain the site's waste resulting from the clean-up. An "unofficial monument to the billions being spent maintaining the country's atomic arsenal", as it was defined by Professor Krupar (2007, p. 31). As stated by Bowers (2018), the case of the containment cell offered a new perspective on risk management. Instead of removing toxins, a device was created to permanently house them, which later will become an integral part of the public heritage experience.

On the other hand, nuclear disaster sites such as Fukushima and Chernobyl had reached a maximum scale of Level 7 based on the International Nuclear and Radiological Event Scale (INES), with plumes of radionuclides spreading across vast territorial regions through the air. Exclusion zones of 30 km and 20 km were set up around Chernobyl and Fukushima Daiichi power plants respectively, and citizens were forced to be exiled away from their hometowns for several decades. These places eventually became 'involuntary parks', where wildlife started to take over in the absence of humans.

Fig. 3 – The Columbia River at the Hanford Reach from the top of White Bluffs north of the Tri-Cities in Washington (photo: Dj Cane, June 2018).

Post-Nuclear Landscapes

After decades, the nature reserves and exclusion zones in the absence of human interference were characterized by lush vegetation reclaiming the streets and cities, and home to an extraordinary abundance of animal species. From no-man's land, they became untouched havens for wildlife (Wills, 2001; Easen, 2003; Pitkanen & Farish, 2018).

As noted by Cram (2015), despite the wounds inflicted by mankind, nature runs its course. If left to its own devices, nature proves it can survive a nuclear disaster. Amazingly, Hanford Site, the most toxic nuclear station in North America becomes an environmental success story, turning into a lush oasis of biodiversity proliferation. In particular, the shrub-steppe landscape of Hanford Reach National Monument, which had sixty years to recover (Zwinger & D.Smith, 2004), saw great recovery (fig. 3). The buffer status had offered protection from the past seven decades of agricultural and suburban sprawl, the Monument now represents a wild paradise, home to a diverse collection of plants and animals, including more than 800 species considered rare. The Monument also blends with the surrounding desert environment, containing one of the largest river complexes in the country, and hosting one of the Northwest's best salmon spawning grounds. Here, it is possible to encounter coyotes, beavers, bobcats, river otters, mink, and cougars grazing close behind the 9 nuclear reactors, which are considered Nuclear Historic Landmarks in importance.

The solution to nuclear contamination, it seems, is simply to let nature be (Cram, 2015), to the point that Mary Mycio, a Ukrainian-American journalist and biologist, questioned whether it is "correct to call it an environmental disaster because the very absence of humans and their interruptions left the natural environment alone, allowing it to thrive." (Coates, 2014)

Even in Chernobyl, nature appears resilient and invigorated as it continues to grow and multiply, with Google satellite imagery gathered from 2002 to 2020 (fig. 4,5) showing green vegetation reclaiming sites and man-made structures. The red forest, the most defiled wasteland in Chernobyl, right at the epicentre of the disaster, has gone through a new 'natural' selection cycle where it once was a pine forest, turned into a desolate nuclear waste burial site, and then regenerated with deciduous birch and black alder and other understorey vegetation that are more radioresistant (Kryshev, et al., 2005;

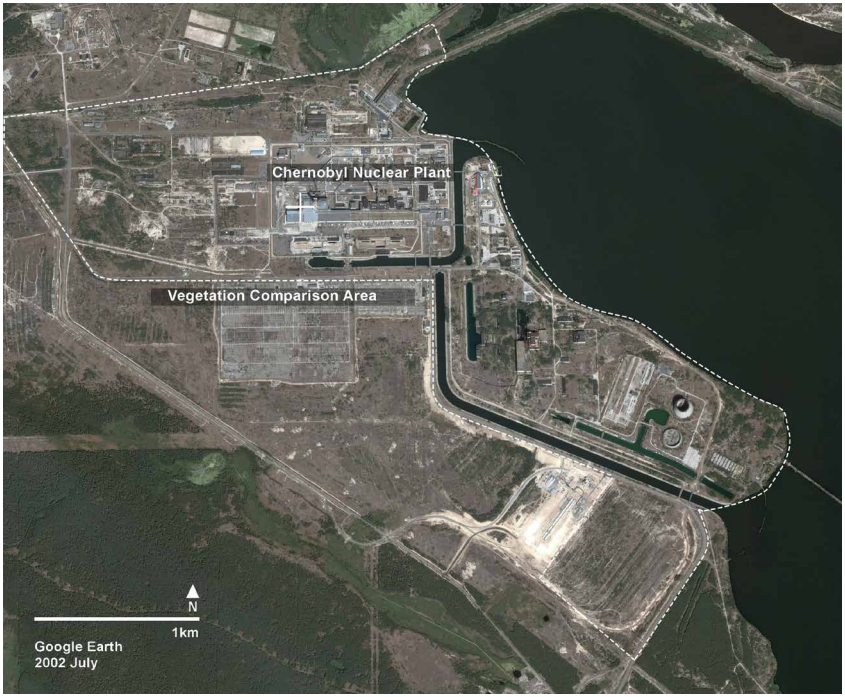

Fig. 4 – Chernobyl Exclusion Zone in July 2002 as observed on Google Earth (photo: authors' elaboration).
Fig. 5 – Chernobyl Exclusion Zone in July 2020 as observed on Google Earth (photo: authors' elaboration).

Fig. 6 – General view of Hiroshima, Japan as seen from the vicinity of 'zero', shows complete devastation as a result of the atomic bombing (photo: National Archives Catalogue, March 1946).

Baresford, 2020). They are living breathing archives of humans' ecocides.

Nuclear Wildness

These post-nuclear landscapes are active and wild, dynamic, and mobile, hardly to be contained; animals, insects, and plants continue to grow and propagate and evolve with the natural processes and the uncanny radioactive agencies they inherited.

When pondering upon his experience in a radioactive site, Nick Rush-Cooper mentioned, "Radiation may be straightforwardly destructive, yet ionising energy excites the cells of landscape-subjects with a certain creativity." (Rush-Cooper, 2019, p. 226)

Living creatures assimilated toxic contaminants into their body, carrying unwanted radioactivity beyond guarded boundaries and necessitating a multi-million-dollar biological vector control program (Masco, 2004). Ironically, Hanford site once an atomic weapon production site, lent nature its radioactive arsenals to deter man from its domain, where mice and rabbits leave radioactive faeces around the area, while wasps and flies often sneak out from the site and encroach human settlements (Cram, 2015). Wilderness and vector become paradoxically enmeshed, positioning nature with the power to mark territories of both injury and recovery, reintroducing a new kind of 'wild'; a post-nuclear wild-ness! (Goh & Grisoli, 2021).

People may romanticise nuclear presence benefiting environmental recovery, where nature seems to be thriving well with overgrowth vegetation and the abundance of wildlife's return, which is evident in the field research of Deryabina et al. (2015). However, this idyllic post-nuclear wild-ness might just be a false perception that humans sought to be-

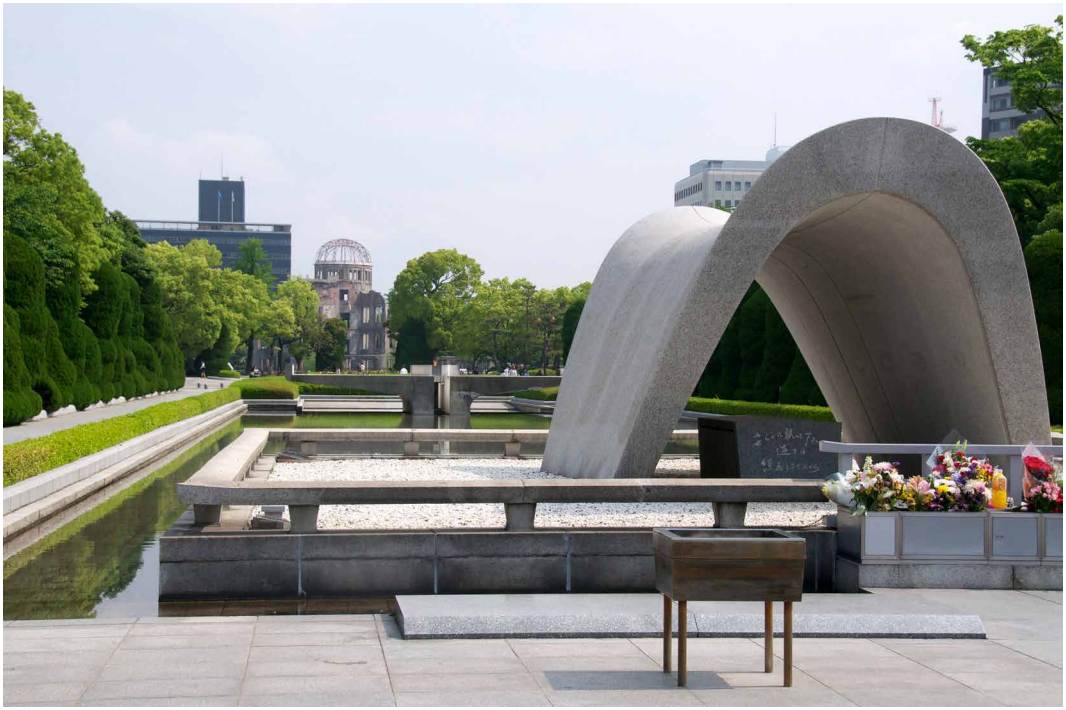

Fig. 7 – Hiroshima Peace Memorial Park: Memorial Cenotaph in the foreground, looking over Pond of Peace, featuring the A-bomb Dome in the background (photo: BrYYZ, May 2012).

lieve, to shroud away their guilt. These anecdotal observations on nature's regeneration elide the cellular transgressions and mutant potentialities that are infesting the living creatures from within. Scientists such as Mousseau and Moller, who conducted wildlife research at Chernobyl, warned that the tragedy that might befall wildlife is transgenerational, where possible perils of mutation accrued within populations will amplify across generations, potentially lowering the mean fitness of the entire population in the long run (Mousseau & Moller, 2011). However, some optimistic biologists like Mycio argued that Nature's Law/Darwin's natural law of selection - survival of the fittest - may retain the strong ones, wildlife will eventuate and evolve with greater resistance towards nuclear radioactivity, further stating, "in the wild, mutants die". (Andrew, 2006).

Nuclear Landscape Monuments

Apart from the ecological and environmental crisis left behind in nuclear production and test sites, nuclear landscape has also left a hallmark of cultural dissonance across the globe. The atomic bombing of Hiroshima (fig. 6) and Nagasaki testified to the horror and destructiveness of nuclear power. Even though those were the last nuclear weapons used on a nation, many nuclear tests were conducted during the 1950s and 60s, mainly in coincidence with the Cold War period. The aftermath obliviates landscapes into an unrecognisable state, disrupting the victims' psycho-geographical perception of their homeland (Clemente & Salvati, 2017).

Examples such as Hiroshima Peace Memorial Park (fig. 7) and The Tomb at Enewetak Atoll (fig. 8) in the Marshall Islands help to reveal the spatial and cultural narrative of the aftermath, highlighting the

Fig. 8 – Aerial view of Runit Dome (or Cactus Dome), Runit Island, Enewetak Atoll. In 1977-1980 the crater created by the Cactus shot of Operation Hardtack was used as a burial pit to inter 84,000 cubic meters of radioactive soil scraped from the various contaminated Enewetak Atoll islands. The Runit Dome was built to cover the material (photo: US Defence Special Weapons Agency, 1980).

significance of nuclear landscapes monuments, as bearers of memories, reconciling with the atomic past.

On August 06, 1949, the Hiroshima Peace Memorial City Construction Law, which is also known as the 'Peace urban law', initiated the construction of the Hiroshima Peace Memorial Park (Li & Niell, 2018). The park was highly significant as it was a momentous proposal that marked a new start for Japan. it was the first official attempt to memorialise the unprecedented use of the atomic bomb and commemorate the end of the destructive war. Furthermore, it encapsulated the society's collective spirit to move forward into a new future of peace, being granted a special status as 'mecca' of world peace (Cho, 2012).

Just as Langhorst (2012) mentioned that landscape and place are both artefacts and agents in a continuous interplay of natural forces and human activity – which inadvertently created multifaceted narratives over time.

Hiroshima Peace Memorial Park, with all the entangled cultural, political and historical narratives accrued over time since its inception, holds evidence of the destructiveness of the atomic blast. It is not an isolated impact on a place and its people, but collateral damage to humans' psyche as a collective and as a nationhood.

Every year on the 6 August, Peace Memorial Ceremony is held at the Park to comfort the spirits of those killed by the atomic bomb and also to pray for lasting world peace (Hiroshima, 2018). Locals and visitors from all around the world would gather around the arched concrete memorial Cenotaph and the Flame of Peace, performing a collective ritual to commemorate those who fall victim to the nuclear disaster, reminding people of the horrors that nuclear brings.

As for Enewetak Atoll, it was severely devastated and the Marshallese were displaced from their homeland (Rust, 2019). The Tomb, a greyish 110-meter-wide concrete dome was erected on top of a crater (fig.9) left behind by the US nuclear test to hold all the radioactive contaminants that were left behind. What was just an encasement of radioactive waste had become a NLM which reminds the islanders of the sufferings, being robbed away from their homeland, and the physical destruction and contamination of their land and sea.

In 1988, the local residents came back to inhabit the island once the Atoll was announced safe for living.

Fig. 9 – Crater created by the Cactus shot of Operation Hardtack I. The 18-kt detonation occurred on 5 May 1958 on Runit Island, Enewetak Atoll. The crater had a diameter of 105 meters and a maximum depth of 11 meters with a 2.5 to 4-meter lip (photo: Federal Government of the United States).

The Marshallese had been fighting for their rights and bringing nuclear negligence to light (Willacy, 2017). Somehow all these events and activisms, be it in the form of memories or visceral experiences are all encapsulated within the NLM. The Tomb remained a significant entity in the atomic history, a form of reconciliation or remembrance, signifying both destruction and hope.

Conclusion

In conclusion, humans saw great transformations on the Earth's surface during the age of Anthropocene, especially from the implications of nuclear power. Nuclear landscapes may be barren or forsaken from nuclear disasters and contamination, but nature will continue to run its course, with or without human interventions. Through natural selection, succession and evolution, the garden of apocalypses or post-nuclear landscapes slowly recover with lush vegetation and the return of wildlife. However, their assurance of existence still falls short under humans' negligence.

As Eric Dieterle (2002, p. 227) states: "nature changes, evolves, creates, and destroys; it flies wildly out of balance and sometimes, but not always, returns to form."

Humanity's grasp on nuclear power had altered the very "nature" of nature, creating nuclear landscapes that entangled with both anthropogenic and natural agencies, a place of bewilderment replete with polar parities of fear and awe, discovery and destruction, death, and rebirth (Engler, 2004). This kind of nuclear wild-ness is an entropy that is forever changing and evolving, and their indeterminacies may be haunting or beautiful depending on humans' future actions and their acceptance towards co-existing with nature and the "unnaturally" nature.

The awareness of these vicissitudes entailed great sacrifices and forever changed mankind's relationship with nature, or the "other", from domineering control over nature to co-existing with nature. It is a co-evolutionary relationship, knowing that dependency among humans and non-humans is vital for future generations to thrive.

Hopefully, nuclear landscape monuments being artefacts leftover from an Anthropocentric human history have the power to inculcate specific concepts such as reconciliation, conservation, and planetary co-existence, reminding people of the failures of the atomic past. They are symbols of past devastation, yet they are also promises of hope. Their ability to bind past experiences and the present place together invokes commonly shared human thoughts, sentiments, and moral attitudes towards nuclear power, which is described by Yoneyama (1999, p. 12) as "nuclear universalism." Hopefully, with ritual and ceremony, together with advocacy and activism, nuclear landscape monuments could continue to perpetuate such awareness into the future, so that the tragic past shall not happen again. Lest we forget.

Note

[1] The group of young scientists was nicknamed *The boys from Via Panisperna* because in the 1930s they worked at the Royal Institute of Physics of the University of Rome, then located at 90 Via Panisperna. The group's main discovery was, in 1934, the property of slow neutrons, which initiated the creation of the first nuclear reactor and later the atomic bomb. Fermi's collaborators included Rasetti, Amaldi and Segrè.

[2] This epithet is addressed by author Christopher Thomas Pineo to the Hanford Nuclear Reservation and its landscape in his thesis entitled "In the Garden of the Apocalypse: Narrating Myth and Reality in the Hanford Landscape." (2013)

Bibliografia

Alexis Martin, B., Malin, S. & Davies, T., 2016, *Will mankind survive the anthropocene? Experts warn nuclear weapons will make the 'age of man' even more dangerous - and could wipe us out entirely.* <https://www.dailymail.co.uk/sciencetech/article-4014428/Will-mankind-survive-anthropocene-Experts-warn-nuclear-age-set-dangrous-wipe-entirely.html> (07/21).

Andrew, O., 2006, *Life Returns to Chernobyl; The World's Worst Nuclear Accident Created a Radiation-soaked Wasteland. But Nature Has Pushed Its Way through the Cracked Concrete, as Andrew Osborn Reports 20 Years after Meltdown.* «The Independent», p. 20.

Baresford, N., 2020, *Field Effects Studies in the Chernobyl Exclusion Zone: Lessons to Be Learnt*, «Journal of Environmental Radioactivity», vol. 211.

Bowers, T., 2018, *Heterotopia and Actor-Network Theory: Visualizing the Normalization of Remediated Landscapes*, «Space and Culture», pp. 28-46.

Cho, H., 2012, *Hiroshima Peace Memorial Park and the making of Japanese postwar architecture*, «Journal of architectural education», vol. 66, n. 1, pp. 72-83.

Clemente, M. & Salvati, L., 2017, *'Interrupted' Landscapes: Post-Earthquake Reconstruction in between Urban Renewal and Social Identity of Local Communities*, «Sustainability», vol. 9, n. 11.

Coates, P., 2014, *No-Man's Land, Nature's Wonderland: Troubled Humanity and Untroubled Earth*, «Environment and History», vol. 20, n. 4, pp. 499-516.

Cram, S., 2015, *Wild and Scenic Wasteland: Conservation Politics in the Nuclear Wilderness*, «Environmental Humanities» vol. 7, pp. 89-105.

Department of Energy, O., 2007, *The Columbia River at Risk: Why Hanford Cleanup is Vital to Oregon.* <https://web.archive.org/web/20100602110418/http://www.oregon.gov/ENERGY/NUCSAF/HCleanup.shtml> (07/21).

Deryabina, T. et al., 2015, *Long-term cencus data reveal abundant wildlife populations at Chernoby*, «Current Biology», vol. 25, n. 19, pp. 824-826.

Dieterle, E., 2002, *Wasteland or sanctuary? Post-Apocalyptic Life in a Nuclear Landscape*, «Interdisciplinary Studies in Literature and Environment», vol. 9, n. 2, pp. 225-230.

Easen, N., 2003, *Korea's DMZ: The thin green line,* CNN International <http://edition.cnn.com/2003/WORLD/asiapcf/east/08/22/korea.bio.dmz/> (07/21).

Engler, M., 2004, *Post nuclear Monuments, Museums, and Gardens,* «Landscape Review», vol. 9, n. 2, pp. 45-58.

Funabashi, H., 2012, *Why the Fukushima Nuclear Disaster is a Man-made Calamity,* «International Journal of Japanese Sociology», pp. 65-75.

Gan, E., Tsing, A., Swanson, H. & Bubandt, N., 2017, Introduction: Haunted Landscapes of the Anthropocene, in: Arts of Living on a Damaged Planet: Ghosts and Monsters of the Anthropocene, University of Minnesota Press, pp. 1-15.

Goh, G. & Grisoli, L., 2021, *Nuclear Wildness,* «KERB», pp. 78-81.

Hiroshima, V., 2018, Visit Hiroshima. <https://visithiroshima.net/things_to_do/seasonal_events/summer/hiroshima_peace_memorial_ceremony_peace_message_lantern_floating_ceremony.html> (06/21) Krupar, J., 2007, *Burying Atomic History: The Mound Builders of Fernald and Weldon Spring.* «The Public Historian», vol. 29, n. 1, pp. 31-58.

Kryshev, I. I., Sazykina, T. G. & Beresford, N. A., 2005, *Effects on wildlife. in: K. Smith & N. A. Beresford (eds.), Chernobyl - Catastrophes and Consequences,* Springer, Praxis Publishing Ltd, Chichester, UK, pp. 267-287.

Laghorst, J., 2012, *Recovering place: On the agency of post-disaster landscapes,* «Landscape review», vol. 14, n.2, pp. 48-74.

Li, M. & Niell, D., 2018, *Activities and Roles Played by Architects in the Reconstruction of Hiroshima after its Atomic Bombing,* «International Review for Spatial Planning and Sustainable Development», vol. 6A, pp. 53-78.

Masco, 2004, *Mutant Ecologies: Radioactive Life in Post-Cold War New Mexico,* «Cultural Anthropology», vol. 19, n. 4, pp. 517-550.

Mousseau, T. & Moller, A., 2011, *Landscape portrait: A look at the impacts of radioactive contaminants on Chernobyl's wildlife,* «Bulletin of the Atomic Scientist», vol. 67, n. 2, pp. 38-46.

Pitkanen, L. & Farish, M., 2018, *Nuclear landscapes,* «Progress in Human Geography», vol. 42, n. 6, pp. 862-880.

Rush-Cooper, N., 2019, *Nuclear landscape: Tourism, Embodiment and exposure in the Chernobyl Zone',* «Cultural Geographies», vol. 27, n.2, pp. 217-235.

Rust, S., 2019, *How the US betrayed the Marshall Islands, kindling the next nuclear disaster,* «Los Angeles Times». <https://www.latimes.com/projects/marshall-islands-nuclear-testing-sea-level-rise/> (06/21).

Segrè, G. & Hoerlin, B., 2017, *Il papa della fisica. Enrico Fermi e la nascita della bomba atomica,* «Milano: Raffaello Cortina Editore».

Sertorio, L., 2008, *L'energia nucleare in Italia. il Mulino,* «Rivista trimestrale di cultura e di politica», Issue 6, pp. 1035-1044.

Willacy, M., 2017. *A Poison in our island,* «Foreign Correspondent», Australian Broadcasting Corporation. <https://www.abc.net.au/news/2017-11-27/the-dome-runit-island-nuclear-test-leaking-due-to-climate-change/9161442?nw=0> (06/21).

Wills, J., 2001, *'Welcome to the Atomic Park': American Nuclear Landscapes and the 'Unnaturally,* «Environment and History», vol. 7, n. 4, pp. 449-472.

Yoneyama, L., 1999. *Hiroshima traces: Time, space, and the dialetics of memory.* Berkeley: University of California Press.

Zwinger, S. & D.Smith, S., 2004. *The Hanford Reach: A Land Of Contrasts*, University of Arizona Press, USA.