Toward SDGs from Nagasaki University, Japan

Research and Education Activities in Asian Environmental Resilience Research Center (AERRC), Nagasaki University, Japan

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1. Introduction to AERRC

The primary mission of AERRC is to develop a resilience model for a future local society that is in symbiosis with the environment.



History before the AERRC establishment (Activities in cooperation with local communities)

2007	The partnership agreement on the environmental education and research
April	is concluded among Faculty of Environmental Science of Nagasaki University, Environment department of Nagasaki prefecture and Unzen City. Unzen E-camlage program (Unzen eco-campus and eco-village program) is launched.
2007	Hot Spring Power Generation Project at Obama-onsen is launched.





Signing ceremony (April 27, 2007)

Shimabara Peninsula

Unzen E-camlage program (1)

Training camp for new students at Unzen onsen (2008-)





Lecture



Group discussion



Elementary school destroyed by the pyroclastic flow In 1991 (Former Obama elementary school)

Unzen E-camlage program (2) Practical activities with local residents



Rice planting

Biological reseach

Meeting with farmers



Mochi pounding event



Beach cleaning & investigation of marine litter



Agricultural experience

Unzen E-camlage program (3)



Landscape survey at Obama onsen



Obama onsen binary power station (Obama onsen power generation project)





Symposium

Low-carbon town development and regional revitalization (2011~2013, 2016)

Unzen E-camlage program (4)







Lecture room

Exhibition room

Unzen E-camlage Exchange Center (Obama town, Unzen City)

2015	The comprehensive partnership agreement is concluded between Nagasaki
August	University and three cities (Unzen, Shimabara, Minami-Shimabara) in the
	Shimabara Peninsula.





Signing ceremony (August 12, 2015)

Unzen City Shimabara City Minami-Shimabara City

Medium-term Plan of Nagasaki University (2016-2021)

Strategy III: Contribution of knowledge for regional revitalization As a university based in the region, we become the driving force for regional revitalization by returning the results of education and research to the local communities.

- Developing local human resources
- Local industry support through industry academia government collaboration
- Improvement of local retention rate of job seekers
- Solution of various regional issues

History toward the AERRC establishment (Activities in cooperation with local communities)

2007 April	The partnership agreement on the environmental education and research is concluded among Faculty of Environmental Science of Nagasaki University, Environment department of Nagasaki prefecture and Unzen City. Unzen E-camlage program (Unzen eco-campus and eco-village program) is launched.
2007	Hot Spring Power Generation Project at Obama-onsen is launched.
2015 August	The comprehensive partnership agreement is concluded between Nagasaki University and three cities (Unzen, Shimabara, Minami- Shimabara) in the Shimabara Peninsula.
2016 April	Medium-term Plan of Nagasaki University is launched. Asian Environmental Resilience Research Center (AERRC) is formed in Graduate School of Fisheries and Environmental Sciences. Shimabara peninsula eco-challenge (SPEC) is launched.

Medium-term Plan of Nagasaki University (2016-2021)

Shimabara Peninsula eco-challenge (SPEC)

- Development of a resilience model for the Shimabara
 Peninsula
- Development of human resources who can operate the model and contribute to the creation of a resilient local community

Location of Shimabara Peninsula





City	Households	Population
Unzen	15,376	44,115
Shimabara	17,068	45,436
Minami-Shimabara	16,664	46,535

Changes in the population and the number of households in the Shimabara Peninsula



Unzen Volcano



Characteristics and issues of the Shimabara Peninsula (1)

Agriculture





Potato field before planting

XThe biggest agricultural zone in Nagasaki Prefecture

- Ratio of full-time farmers is 34%. (cf. 24% for whole Nagasaki Pref.)
- •Livestock industry (milk cow: 75.8%, hen's egg: 76.3% in the gross pref. products)
- Total production of agriculture accounts for 44.6% of Nagasaki Pref.
 (2014)

Problems related to agriculture

- Ground water pollution by nitrate nitrogen
- Problem of animal waste treatment
- Field damage by animals
- Expansion of abandoned farmland
- Bad effects on crops caused air pollution

Characteristics and issues of the Shimabara Peninsula (2)

Natural disaster

Volcanic disasters at Unzen Volcano

Year	Volume of extruded lava	disaster	dead
1663	0.005km ³ Lava flow	Mud flow	30
1792	0.02km ³ Lava flow	Debris avalanche & Tsunami "the Shimabara Catastrophe"	ca. 15,000
1990-1995	0.2km ³ Lava dome	Pyroclastic flow	44



Shimabara Peninsula after the sector collapse of Mt. Mayu and tsunami in May 1792. (Honkoji Temple in Shimabara City)

The 1792 Shimabara Catastrophe

Fugendake (Mt. Funge)

Pyroclastic flow deposits

Ariake Sea

Mayuyama (Mt. Mayu)

Coastal line before 1792

Tsunami

himabara City

The 1990-1995 eruption Dome growth and pyroclastic flows (block-and-ash flows)







Lava dome

Collapse of lava dome



Natural disasters that can occur in the future

- Large collapse of lava dome triggered by a big earthquake. Depending on the scale, the collapsed debris is expected to reach the sea.
- Heavy rain and debris flows
- Weather disasters (typhoons, storm surges, etc.)



Debris flow (Lahar) by heavy rain



Renewable energy

Unzen City : Renewable Energy Potential (Wakeyama and Ehara, 2009)

- Geothermal energy 45MW
- Wind energy 7.6MW
- Solar energy 1.1MW
- Hydropower 1.7MW

Total 55.4MW

If all of these were used, the electricity self-sufficiency rate would be 827%.

Characteristics and issues of the Shimabara Peninsula (4)

Tourism resources



Unzen (Nita pass)



Remains of Hara Castle (World Cultural Heritage)

- First national park in Japan (1934)
- First UNESCO global Geopark in Japan (The Unzen volcanic area global Geopark) (2009)
- Remains of Hara Castle was certified in the World Cultural Heritage "Hidden Christian Sites in the Nagasaki Region" (2018)



What's a Geopark?

A Geopark is a defined region where geologic heritage sites are managed under the concept of "protection, education and sustainable development" (UNESCO, 2010)

Main theme of the Unzen volcanic area global geopark

Coexistence of people and active volcano

- A geopark which boasts an active volcano is very unique worldwide.
- People living in the Shimabara Peninsula have coped repeatedly with volcanic eruptions of Unzen.
- People have made the best use of the blessings from the volcano. http://www.unzen-geopark.jp/en-first

Four research units in Shimabara Peninsula eco-challenge (SPEC)

Environmental pollution unit

Natural disaster unit

Energy unit

Human resource

development unit



Acquisition of regional resilienceRegional revitalization

Environmental pollution unit

- Purification and recovery of water resources contaminated by agriculture
- Understanding the actual situation of transboundary air pollution and studying the effects on living organisms and crops



End hunger, achieve food security and improved nutrition and promote sustainable agriculture (Target 2.4)

Ensure healthy lives and promote well-being for all at all ages (Target 3.9)

Ensure availability and sustainable management of water and sanitation for all (Target 6.3)

Ensure sustainable consumption and production patterns (Target 12.5)

Atmospheric observation station (Measurements of PM2.5)



The stations were installed at different altitudes from 20 m to 1300 m in the Shimabara Peninsula (T. Nakayama et al., 2019).

Natural disaster unit

- Construction of natural disaster database (earthquakes, volcano, weather)
- Construction of an adaptive governance model for disaster risk





Chijiwa Fault



Make cities and human settlements inclusive, safe, resilient and sustainable (Target 11.b)

Take urgent action to combat climate change and its impacts (Target 13.1)

Energy unit

- Continuous hot spring monitoring
- Establishment of a protection and utilization model for geothermal energy
- Utilization of unused resources based on assessment of renewable energy potential



Hot spring monitoring (Obama onsen)



Ensure access to affordable, reliable, sustainable and modern energy for all (Target 7.2)

Ensure sustainable consumption and production patterns (Target 12.2)

Human resource development unit

 Establishing an educational program for the development of human resources who can operate the resilience model and contribute to the creation of a resilient local society





Field school



Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (Target 4.7)

Development of a resilience model

for the Shimabara Peninsula



Energy unit

3. Hot spring power generation project at Obama-onsen (hot spring)



Geothermal energy in Japan

- Japan has the third largest geothermal resource in the world following the US and Indonesia (20,540MW).
- However, the amount of geothermal power generation is 10th in the world.
- Main problems are cost performance, a national park problem, and confrontation between geothermal developers and hot spring owners.

Merits of geothermal energy

- Stable regardless of weather
- · Low CO₂ emissions
- · Pure domestic production
- · Renewable resource

Obama-onsen

- (1) There are approximately 30 spring sources along a 1500-m stretch of the seaside that produce about 15,000 tons of hot water per day at a temperature around 100°C.
- (2) As almost all of the hot water is used only for bathing, about 70% of the hot water is unused and is released into the sea.
- (3) It is estimated that the untapped hot water and waste heat at Obama-onsen have the power generation capacity of about 2,000 kilowatts.





Unused hot water which is released into the sea.

Obama onsen

Obama onsen: History of hot spring use and development plan

•1941-1961

Start of salt making business using hot spring water, more than 100 wells, consuming 40,000 to 50,000 tons per day.

As a result, Obama onsen was in danger of exhaustion.

2003-2005

NEDO (New Energy and Industrial Technology Development Organization)

- Geothermal development promotion survey
 Drilling survey →1500kW power generation plan
 Drilling survey was canceled due to local opposition.
- Industrial technology development
 250kW binary power generation demonstration test
 Canceled after excavation of hot spring well

Salt manufacture during 1941-1961

1955

図27 昭和 30 年の源泉及び旅館位置(源泉の番号は調査番号)



図30 昭和62年4月源泉及び旅館位置図(源泉の番号は温泉台帳番号) Location of wells and hotels in 1987



Location of hot spring wells in 1955 (left) and 1987 (right) (Nagasaki Pref., 1988).

Purpose of the project

Global problems :

Global warming Exhaustion of fossil fuels Promotion of renewable energy

Domestic energy problems :

Increasing the self-sufficiency rate Stable energy supply Decentralization of energy

supply Distrust to nuclear energy

Local problems :

A lot of unused hot spring water Economic downturn Population decrease and aging Tourist decrease Since the Obama-onsen has a high temperature, the local residents have been struggling for a long time to lower the temperature to 42 $^{\circ}$ C for bath use.

Beginning in 2007, we held discussions on binary power generation using untapped hot water, among the local university, the local communities, industry and local governments. In March 2011, the Obama-onsen promotion conference for utilizing geothermal energy was organized, aiming at realizing a low-carbon hot spring area and revitalizing the town by using geothermal energy.



Reduction of CO₂ emissions Promotion of industry and job creation Revitalization of the hot-spring area Environmental and energy education



Obama-onsen promotion conference for utilizing geothermal energy (Mar. 8, 2011)

Chronology



Process of binary-cycle power generation





Inside of the Obama-onsen binarycycle power station.

(1)make hot water by the heat of the hot-spring water
 (2)evaporate the low-boiling-point liquid with hot water
 (3)generate power by turning the turbine with power from the steam
 (4)cool the gas return to a liquid

Binary power generation is a method of turning turbines with steam that is heated and evaporated by a heat resource using a liquid with a lower boiling temperature than water. First, this power station conducts heat exchange between the tap water and spring water, and then the tap water that has been warmed is sent to the power generator as a heat source. Highly secured CFC substitutes are being used for the lower-boiling-temperature liquid.

The binary-cycle power generation using hot spring water is environmentally friendly because it doesn't emit CO_2 and may permanently be used as a renewable energy. After the Obama-onsen binary-cycle power station started to work, it was included in a course of geo-tour in the Obama-onsen area. Also, it has been used practically for the environmental and energy education.

Summary of the Obama-onsen hot spring power generation project

- (1)Obama-onsen is a volcanic hot spring with a heat source that comes from the underground magma of Unzen volcano.
- (2)There are approximately 30 spring sources that produce about 15,000 tons of hot water per day at a temperature around 100°C.
- (3)About 70% of the hot water is untapped and is released into the sea.
- (4)In the past, excess pumping for the salt manufacture brought a crisis of drying up of the wells.
- (5)Obama-onsen project was started by cooperation among the local university, the local communities, industry and local governments, aiming at realizing a low-carbon hot spring area and revitalizing the town by using geothermal energy.
- (6)In 2013, a demonstration plant of hot spring power generation was installed, supported by a subsidy (Challenge 25) of the Ministry of the Environment. Since 2015, the plant has been operated in business by a private company.