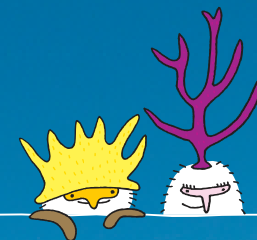


Education for Sustainable Development



ESD Workbook

Coral Reef Islands

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February, 2011

In island nations, there are many problems associated with tourism and people's lifestyles, such as coral reef destruction, waste and global warming. If this goes on, we will not be able to live on this planet much longer.

In order to figure things out, we need to understand the interconnections among these problems and work on them holistically.

Activities that teach people to work proactively to solve problems in the aim to create a sustainable society are called, collectively, Education for Sustainable Development (ESD).

Since the year 2005, people all over the world have been involved in this as part of the UN's Decade of ESD.

This booklet, developed by the ESD Research Center at Rikkyo University, contains a study on coral reefs to be used as ESD teaching material.

Please enjoy the coral study.

Let's start the work!

Osamu Abe, Director of ESD Research Center, Rikkyo University



For students



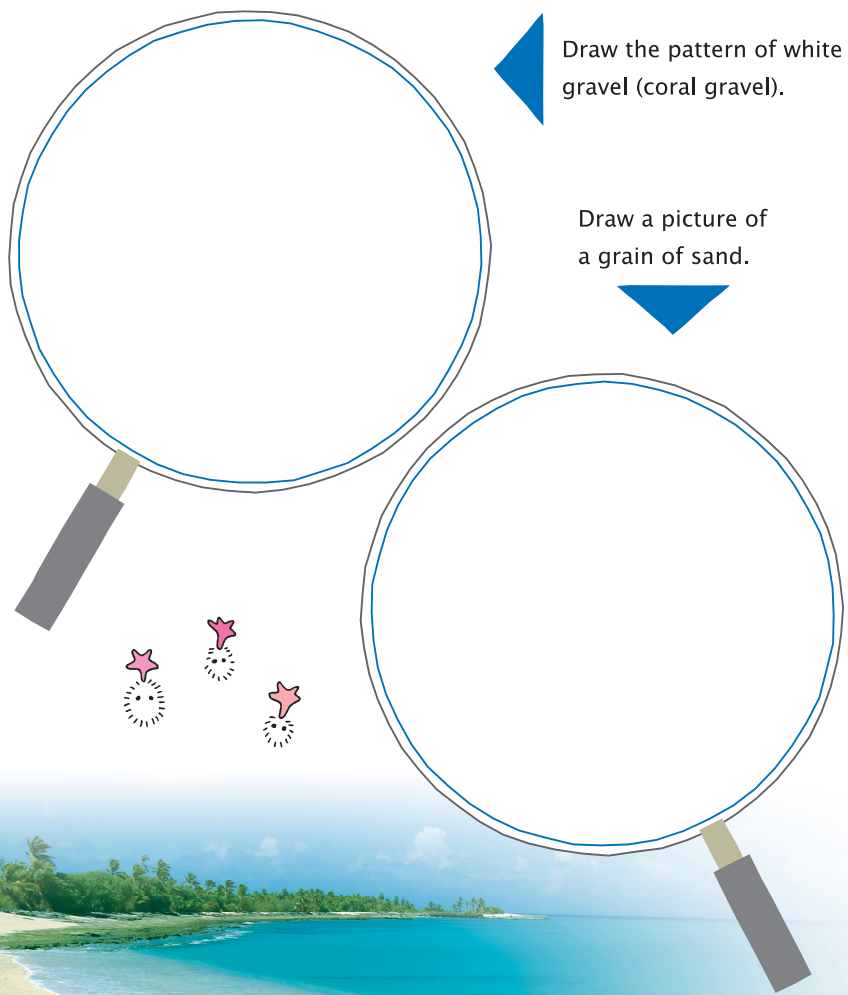
Picture guide



For teachers

1 What is this?

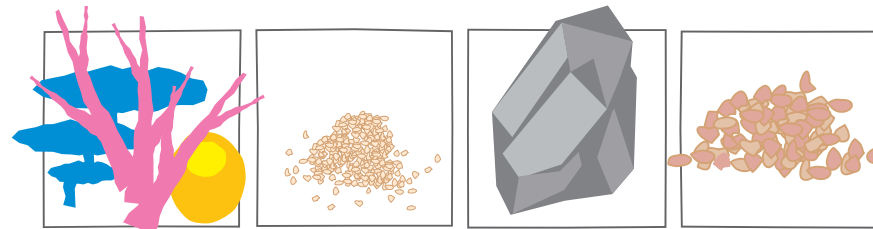
Let's go to the sea coast and look closely at the white gravel and sand under our feet!



2 What is our island made of? How was it created?

Look at the sea: the color and the surface.

What is our island made of?



Coral

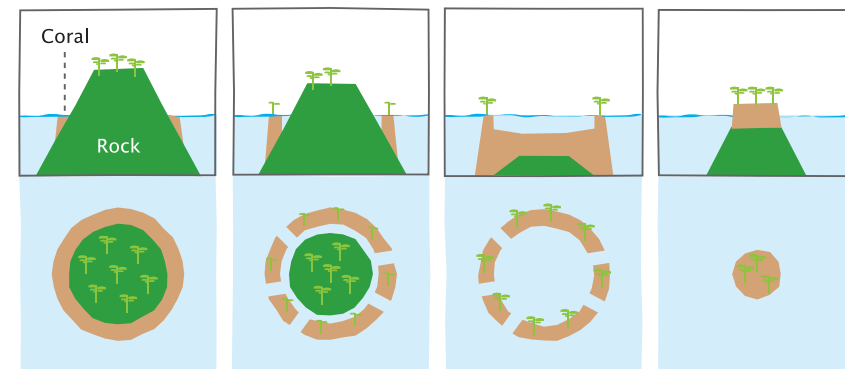
Sand

Rock

Soil



Which type of coral is our island made of?



Fringing reef

Barrier reef

Atolls

Raised coral reef





What is this? Picture guide



Wonder of coral and star sand

Let's look at rocks on the coast !

When you pick up a piece of white gravel or sand and look at them, you will see there are many small holes in them. This means it is a piece of dead coral (Fig. 1). Most of the white gravel and sand you see are spalls of coral.

The small holes (Fig. 2) are where coral polyps (Fig. 3) live. Coral polyps are in a close relationship with the sea anemone (Fig. 4-1, 2, 3). Sea anemones have toxic stinging cells inside their tentacles, and they stretch their tentacles to sting small fish and crustaceans. This is how sea anemones hunt them. Coral polyps are very small, so they hunt small plankton instead. Unlike the sea anemone, coral polyps hide inside their skeleton (Fig. 5) during the daytime to avoid fish. The small holes are like shelters for coral polyps to hide in and survive. At night, when their enemy fish are sleeping, coral polyps come out from their holes and hunt plankton (Fig. 6).

The coral polyp's body is covered by an exoskeleton. The coral polyp's exoskeleton protects its body.

The exoskeleton is made of lime (calcium carbonate), the same substance that human bones and seashells are made of. Coral polyps unite under the skeleton (—It is called a "coenosarc"—), and they live in colonies of tens of thousands. When one of the coral polyps in the colony feeds

itself, it nourishes the entire colony.

Coral polyps form a symbiotic relationship with phytoplankton (Fig. 7). This is called zooxanthellae. (Fig. 8) Zooxanthellae algae perform photosynthesis to create energy. This enables the coral reef to grow with the nutrition provided by the zooxanthellae. Most sand is either a round shape or has spurs. It is foraminifer shells (Fig. 9). Foraminifera (Fig. 10) are benthic organisms that inhabit a reef flat.

There are some sea coasts where half of the sand consists of foraminifera shells. Foraminifera which don't have spurs, but are star-shaped, are called star sand. When you look at the rocks, some of them have coral fossils. (Fig. 11)

Most of the rocks are either coral fossils, or sedimentary rock (Fig. 12) formed by corals. Sedimentary rock is transformed into lime rock in deep water. There are islands where most of the land is made of lime rock. Lime rock contains large amounts of carbon dioxide, and it affects the world's climate.



Both sand and rock are made of coral or from other life in the reefs.



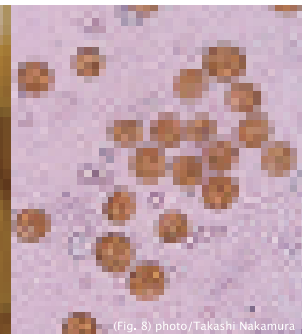
(Fig. 6) photo/Yoshihisa Fujita



(Fig. 4-1)



(Fig. 4-2) photo/ipa.go.jp



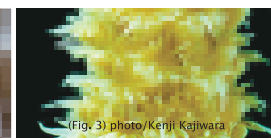
(Fig. 8) photo/Takashi Nakamura



(Fig. 4-3) photo/ipa.go.jp



(Fig. 2)



(Fig. 3) photo/Kenji Kajiura



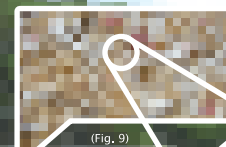
(Fig. 5) photo/Yoshihisa Fujita



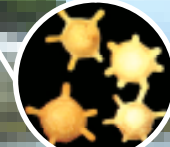
(Fig. 1)



(Fig. 11)



(Fig. 9)



(Fig. 10) photo/Kenji Kajiura

(Fig. 12)

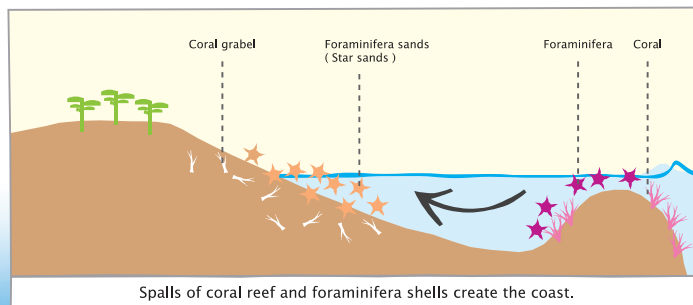
Interpretation for What is our island made of?



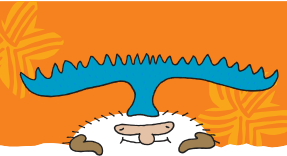
What is our island made of?

This is coral, and that's also coral. Everything is coral!

- Have you ever noticed that there are light blue parts and blackish-colored parts when you look at the sea? Under the light blue parts there is white sand, and in the blackish-colored part there are coral communities.
- Foaming waves mean the sea level is shallow. It is the best place for the coral to develop. Corals also prevent strong waves of the outer sea from reaching the island. Corals protect the islands like a fort. Thanks to the corals, the inner sea is shallow and quiet, while the outer sea has a steep drop-off. This is called a reef.
- Right inside of the reef is the best place for the foraminifera to live. The shells of foraminifera and corals will be washed ashore and become part of the coast.
- Under the coral, there is rock that is made of coral shells. All the way down under the living reef, the rock is made from coral.
- Most of the islands in the Pacific Ocean are made of coral and other life in the reefs.



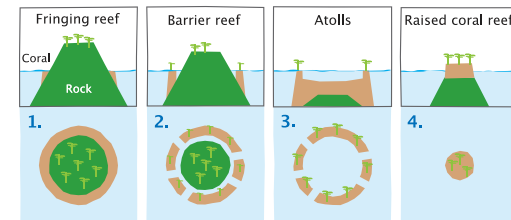
Interpretation for How was it created?



Which type of coral is our island made of?

The answer :

Here are some explanations of how various type of coral islands are created.



Fringing reef :

When a volcano erupts in the middle of the ocean, it creates an island. If the sea is warm, coral reef starts to develop around the island. Since the coral develops around the island's fringe, it is called a fringing reef.

Barrier reef :

When corals develop offshore in deep water, they are called a barrier reef.

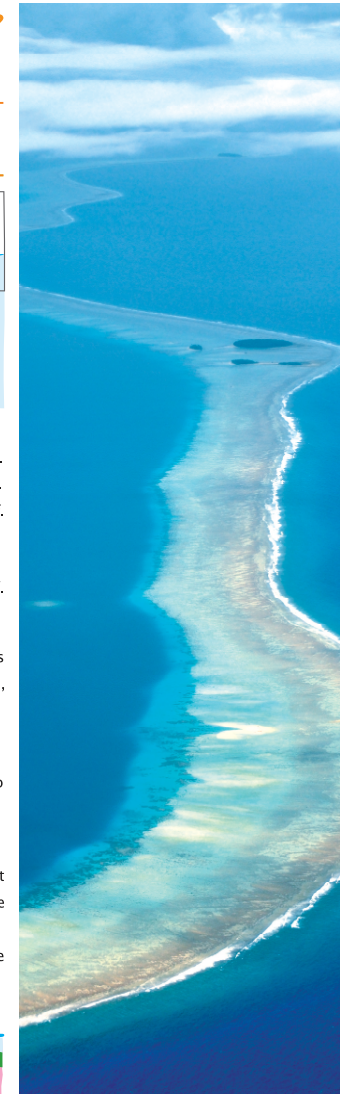
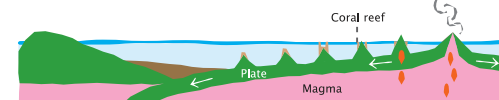
Atolls :

When a coral reef grows at a faster rate than a volcanic island sinks and the coral remains on the surface of the water as a ringed island, it is called an atoll reef.

Raised coral reef :

Once when coral island sinks under water and then rises up again to the surface, it is called raised coral reef.

- Our home, Planet Earth, has thick melting magma in its center. The Earth's crust moves slowly. The movement of the Earth's crust is caused by the movement of the Earth's magma core. Islands in the Pacific Ocean move up and down with the crust's movement. When the crust starts to settle out along with an island, and if the coral reef's growing rate was higher than the settling, it creates land.



3

What have you found on the coast?



Make a list of things

you see in the coast in separate groups.

You can also discuss this with your friends.

Think about why it's here,
and what they will be like in years to come.

Sea-derived driftage



Artificial materials
(garbage)

Land-derived driftage

4

What is going on under the sea?



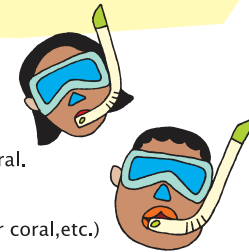
Before you start snorkeling

[CAUTION!]

1. Listen to your leader carefully.
2. Stay in pairs with your buddy, and never to lose sight of one another.
3. If you are not a strong swimmer, put on a life jacket.
4. Look out for dangerous sea animals. Be careful, and don't touch them!
5. If you start to get cold or feel sick, tell your leader immediately.

Observation Points

- Look at the differences between living coral and nonliving coral.
- Notice the many different kinds of coral.
(eg. Encrusting coral, Massive coral, Branching coral, Tabular coral, etc.)
- Observe the various kinds of life living in the coral.
- See if there's any coral in trouble.
(Because of garbage, coral bleaching, disease, coral-eating crown-of-thorns starfish, etc.)



Interpretation for What have you found on the coast?

Driftage is various things that drift to the shore. What brings driftage to shore?

Driftage is brought to shore by sea waves, winds, and tidal ebbs and flows. Some of the driftage comes from the sea close to the shore, and some comes from very far away.

[Sea-derived driftage]

Seashells and coral gravel come from right off shore.

Seaweed, called gulf weed, drifts on the surface and spreads its spores for its offspring. The spores drift very far away.

[Land-derived driftage]

Cocoa and pandanus leaves are from this island.

A few of them are from overseas.

[Other nature-derived driftage]

Float stone is from undersea volcanoes.

[As time goes by]

Organic substance can be degraded by sand hoppers and sow bugs (Fig. 1). Seashells and coral shells become sand and gravel and build coasts.

[Plastic garbage] (Fig. 2)

Alone among all the artificial garbage, plastic refuse does not degrade naturally; it disturbs natural degradation and can even bring death to animals (Fig. 3).



Interpretation for The role of the coral reef

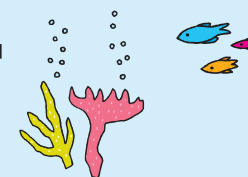


What advantages coral has?

Coral reefs are like schools
where you can learn various things about nature.

Cradle of life

Many fish, shellfish, prawns, crabs, and seaweed live and grow in coral reefs. Coral reefs are also a place to spawn for various kinds of fish.



Food, fishery and resources

Coral nurtures the fish and seafood that we eat.

Coral provides architectural materials, is used in traditional instruments, and provides fertilizer and other various resources.



Protecting islands

Coral reefs act as a breakwater; They weaken sea waves and protect the seashore and islanders. Coral gravel and foraminifer shells help with building a rich coast, and they protect the seashore.



Tourism, education, research and landscape

Beautiful landscapes are a valuable tourism resource.

They can become marine recreation areas for activities such as scuba diving.

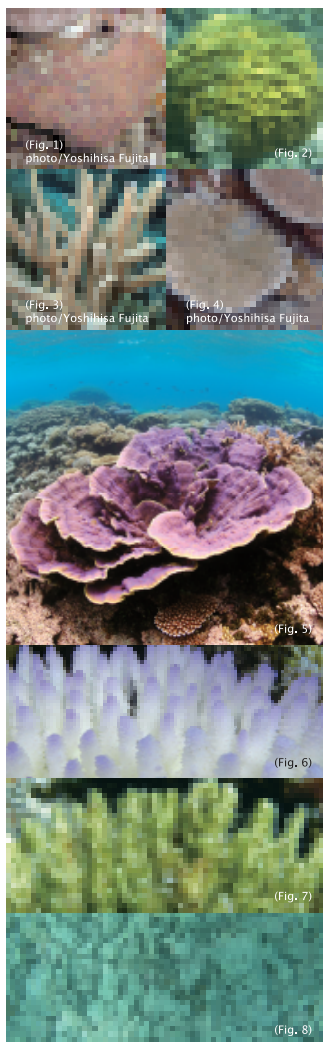




Under the sea? Picture guide



Coral reef

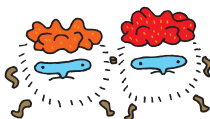


Coral reefs can only develop in the shallow sea where they can receive enough sunlight. Corals usually grow within a depth of 60m of the surface, and the shallower the water the better for coral development.

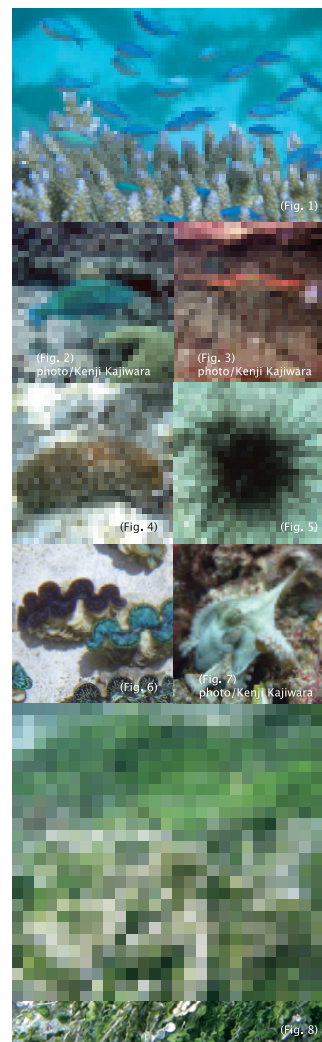
The types and shapes of coral communities depend on the intensity of the sunlight and the waves. Generally, corals are classified into the following types:

- Encrusting corals (Fig. 1)**
develop over rocks. They do not grow tall.
- Massive corals (Fig. 2)**
develop by swelling like a ball.
- Branching corals (Fig. 3)**
develop like tree branches. Branching corals only grow in quiet
- Tabular corals (Fig. 4)**
often develop on the edge of the reef.
Tabular corals are resistant to sea waves.

Living corals are brown, green or purple. Their colors come from their symbiotic algae's pigment (Fig. 5). After coral dies, it quickly turns white. (Fig. 6). Sea algae then grow on the coral and turn it brownish-green (Fig. 7). Thereafter, it disintegrates into dust and becomes gravel or sand (Fig. 8).



Other sea lives



If there is a coral reef in a shallow sea, many types of fish, crabs, prawns, octopuses and seashells live in that area. Corals support their ecosystem by producing food and shelter.

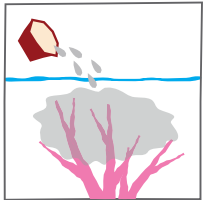
Here are some of explanations of the main sea animals that live in coral.

- Blue-green puller (Fig.1)**
... lives in branching corals. If there was no coral, the blue-green puller would be caught by predators and become extinct.
- Parrot fish (Fig.2)**
... eats corals. It is one of the main food fish eaten by people on the island.
- Spiny lobster (Fig.3)**
... lives in the gaps of the corals.
- Sea cucumber (Fig.4)**
... lives on the bottom of the sea in the coral sand. Sea cucumbers eat organic particles and clean the sea water.
- Long spine urchin (Fig.5)**
... is a type of sea urchin which has long, dangerous spines.
- Giant clam (Fig.6)**
... bores a hole in coral rock and develops. Its beautiful color is from its symbiotic algae.
- Octopus (Fig.7)**
... lives in between corals, and comes out at night to hunt for food.
- Coralline algae (Fig.8)**
... accumulate caustic lime. It also becomes sand when it dies. Coralline algae increase their numbers rapidly when corals are weak.

5 Are coral reefs in danger?



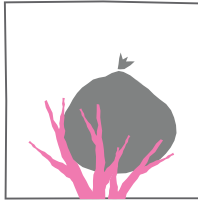
What is bad for coral?



Peeing on coral



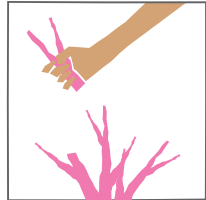
1.



Garbage



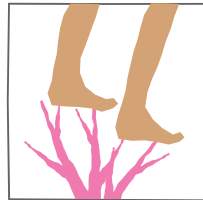
2.



Breaking coral



3.



Standing on a coral



4.

So far, we have learned the great importance of the coral reefs. However, the coral reefs are in serious danger all over the world. Are there any problems happening to the coral reefs of your island?



6 Reviewing a traditional lifestyle



Let's talk about traditional culture.

- Have you ever heard stories about older ways of life from your grandparents?
- Have you ever been to a faraway island where there were no stores?
- Have you ever studied about old ways of life from a book or in class?
- How did that make you feel?



Interpretation for Are coral reefs in danger?



What is bad for coral?

The answer : All of them are bad for corals.

So far, we have learned the great importance of the coral reefs. However, coral reefs are in serious danger all over the world. Are there any problems happening to the coral reefs of your island?

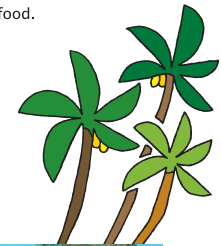
- Sea coast: High tidal waves bring salt water to roads and towns. Sand starts to decrease, and the island gets smaller. Palm trees fall down. This is partly because of the rising sea level caused by climate change. Also, when corals get weak, they cannot stop the strong sea waves and this causes problems of flooding on the coast.
- Corals are weakened by pollution of seawater, garbage dumping and polluted soil.
- Reclamation work and dredging also damage the corals. Development construction should be planned carefully so it does not cause damage.
- Destructive fishery techniques that use toxic substances (chlorine bleach and cyanide etc.) damage corals enormously.
- When the marine environment becomes poor, it may cause coral bleaching and large outbreaks of coral-eating, crown-of-thorns starfish, and it will cause a radical reduction of corals.
- When the destruction rate is higher than the coral development rate, the island cannot recover.
- It is highly important to live while thinking about coral conservation.



Interpretation for Reviewing a traditional lifestyle

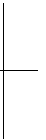


- Our modern way of life brings us wealth but also produces tons of waste. When you throw waste into the sea, it damages our valuable corals.
- In the past, there were no refrigerators to preserve food, and there were no stores to get necessities.
- However the land and the sea were very rich, and they brought people enough food. Everything was able to degrade naturally, and people lived side by side with beautiful nature.
- Nowadays, the world population is increasing, and it may cause a lack of food or energy. If this happens, there may be no food coming to our island anymore.
- Our ancestors lived their life without depending on imported food or material. We should learn from this, and reassess our daily life.





Let's draw a future for a coral island!

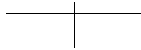


MESSAGE:

COUNTRY:

NAME:

AGE:



Interpretation for Let's draw a future for a coral island!

Let's think about what we can do to save them!

So far we have learned our island is supported by coral reefs.
Do you understand what has bad effects on coral reefs and the sea?

- On the previous pages, there is nothing written. Please think about your future. Think about when you grow up, and what we should do from now on to create a better future. Draw a picture of your life in the future on this island.
- Now the world is globalized, and it is considered as one. This is true for the environment, which we all share in common. The sea is also shared by all of us. The rising sea level issue caused by global warming cannot be solved by the islanders alone. Do you want to make an appeal to the people of the rest of the world? If so, write down the message.



We hope this ESD (Education for Sustainable Development) study
about the coral reef can be of assistance for your future. Thank you.



Afterword



For teachers – Contents for study and development

- This guide book introduces experimental, problem-solving learning about coral reefs, showing the importance of ecosystem conservation to protect islands.
- It is recommended to have an on-site styled class when you use this guide book. However, if you had to have a class inside because of the weather or other reasons, please use samples of corals, foraminifera and driftage. Pictures of coral reefs and sea animals give children a realistic connection to the subjects covered in this guide book.

The activities are as follows:

- 1: Observe coral gravel and sand on the seashore, and understand coral reefs.
- 4: Sort out driftage from the seashore and understand its environmental impact.
- 5 is actually to go look underwater and observe coral reefs. It is recommended that you observe in two places: one place where the coral reef is not damaged and is growing healthily without human influence, and one place where the coral reef is already damaged.

Please consider your own teaching situation and the possibilities for field work, and develop your program accordingly.

This text book is to help children to understand the coral reefs, to encourage children to conserve the coral reefs, treating them with love and respect, to create momentum for worldwide environmental protection, and to be an educational guide book that can be applied for sustainability in the future.

Publisher : Osamu Abe / Director of ESD Research Center, Rikkyo University
 Editor : Ocean Family
 Text and coordination : Yoshiaki Unno
 Illustration and editorial design : Kohei Matsui
 Translation (Japanese to English) : Chihiro Machiya, John David Arambel
 Photos : Hiro Ueda
 Tour arrangement : Tetsuya Sato, Hiro Ueda
 Research support in Marshall : JEJE
 Advisor : Dr.Takako Sato , Hiroshi Nishihara
 Marshall & Workbook project management : Yurie Kaizu

