

# インダス・プロジェクト 2008 年度中間評価報告

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本文は 2008 年 2 月 19・20 日に行なわれた評価委員会に提出した英文報告である。総合地球環境学研究所のプロジェクトは 5 ヶ年にわたって実施されるが、2 年目の年度末にそれまでの研究成果に対して評価委員会による中間評価が行なわれることになっている。以下の英文報告は中間評価に先立って評価委員会に提出したものである。本プロジェクトの成果の位置づけを知っていただくための参考資料として、以下に転載する。

## Interim Report

Project title: Environmental change and the Indus civilization

Project leader: OSADA Toshiki

Abbreviation: Indus Project

Home page: <http://www.chikyu.ac.jp/Indus/>

Key words: Indus civilization, human-environment interaction, Ghaggar-Hakra (Sarasvati) river, climate change, disintegration of Indus civilization networks, Indian Ocean Dipole

### SUMMARY OF RESEARCH OBJECTIVES AND CONTENTS

#### a) Research Objectives

The Indus civilization spread over 680,000 sq. km. of northwestern South Asia. Indus people established and maintained cities like Mohenjo-daro and Harappa from 2600 BC to 1900 BC (Mature Harappan).

Our project aims to investigate the causes of the collapse of the Indus civilization — especially the process of the disintegration of its networks which connected regional societies and cultures. We will examine this process from the perspective of human-environment interaction.

As for natural environment, environmental change will be investigated through natural scientific approach, mainly using geological methods. The target of research includes climate change at the global level and local environmental changes such as river avulsion. As for human factors, the socio-cultural organizations of the Indus civilization and its historical relationships with other societies/cultures will be investigated through humanistic approach, using archaeological, anthropological and linguistic methods. They include collection and analysis of archaeological materials excavated from important sites, ethno-botanical analysis of agricultural systems, linguistic analysis of Vedic texts and Mesopotamian cuneiform texts, etc.

By the end of our project, we will integrate the outcome of all these studies and present a possible scenario of the collapse of the Indus civilization.

#### b) Background

The decline of the Indus civilization has been studied from two different perspectives. The first group of researchers proposed that the main causes for the decline of the Indus civilization were local. There have been several different theories based on this local hypothesis — e.g. Wheeler's Aryan invasion theory and Raikes' flood theory. The second group of scholars, on the other hand, has examined the issue from the global level. They focused their study on the global climate change observed during mid- and late Holocene. They claim that the Old World, especially Asia, witnessed a collapse of agriculture-based societies including the Indus society during mid- and late Holocene which was coincidental with an abrupt climate change.

The past decade has seen a revival of 'environmental determinism' in palaeo-environmental research, with palaeo-climate shifts implicated in the collapse of many past civilizations. We do not accept the environmental determinism proposed by many scholars engaged in global-level analysis, but we also consider that it is important to integrate the outcome of the palaeo-environmental research in northwestern South Asia into our project. Our standpoint is that we need to look at both local and global levels.

#### c) Research Methods

So far most scholars working on the archaeology of the Indus civilization have focused their study on the sites along the Indus river system; e.g., Mohenjo-daro and Harappa. Our project, on the other hand, will investigate wider contexts including the sites along the Ghaggar-Hakra river and in the coastal area of the Kachchh district in Gujarat.

For the reconstruction of the palaeo-environment of the Indus civilization, geological methods are employed to investigate tectonic movement and river avulsion. The subsistence system, on the other hand, is being studied through ethno-botanic and archaeo-botanic analysis.

For understanding the human-environment interaction we also need to collect and analyze the socio-economic and cultural data. These data help us examine human responses to environmental changes in the Indus civilization. We employ various methods of humanities to collect these data: archaeological methods to recover cultural artefacts from the archaeological sites, and linguistic and anthropological methods to discover characteristics of the Indus societies at different levels. Our archaeological teams have already excavated sites at Kanmer (Kachchh, Gujarat, India) for three years and at Farmana (Rohtak, Haryana, India) for two years in collaboration with Indian archaeologists.

#### d) Project Organisation

We have four working groups; (1) palaeo-environment research group (PERG); (2) material culture research group (MCRG); (3) subsistence system research group (SSRG); and (4) inherited culture research group (ICRG). (1) PERG aims to investigate: (a) the palaeo-channel of the Ghaggar-Hakra river through the analysis of high-resolution satellite imagery and field research; (b) the coastline in Gujarat during the Harappan period through the analysis of satellite imagery and core sampling from the Lake Nal located in Gujarat; (c) climate change through the analysis of sea surface temperature using proxy data obtained from coral in Maldives; (d) environmental changes using core samplings from Lake Rara in the Sub-Himalayan region through pollen and phytolith analysis; (e) palaeo-seismological patterns for understanding the impacts of earthquakes on the Indus civilization.

(2) MCRG excavates two sites in India, i.e., Kanmer and Farmana. They have been recovering cultural artefacts such as remains of Indus settlements, Indus seals, Harappan pottery, etc.

(3) SSRG reconstructs the subsistence system of the Indus civilization; for this purpose they use both archaeo-botanical data from Harappan sites, ethno-botanical data collected in field work and proxy data obtained through phytolith and pollen analysis.

(4) ICRG reconstructs the Indus society using linguistic methods. Among them the Indologist subgroup analyzes Vedic and Mesopotamian cuneiform texts, while the linguistic subgroup uses linguistic comparative method to reconstruct the substratum cultures and languages in South Asia. They also have been building up a database of South Asian languages.

#### e) Progress up to Now

So far we have achieved three major findings, one each from the work of MCRG, PERG and SSRG.

(1) MCRG found that there are both similarities and differences in the artefacts of the two regions where they have excavated. This seems to suggest the existence of strong regional differences as well as trading and other kinds of networks which united them. It is due to this finding that we have rephrased the objective of our project. The artefacts found from both excavated sites which show similarities include: Indus seals with Indus script, Harappan pottery, several kinds of beads made from carnelian, steatite, faience, lapis lazuli, etc. Significant difference, on the other hand, is observed in construction materials; i.e., at Kanmer we find local stone-made constructions, while at Farmana there are sun-dried brick-made constructions. In addition, we observe the existence of different kinds of local pottery at each site.

(2) PERG found that the Ghaggar seems to have been rather a small river easily affected by the quantity of rainfall in the monsoon season. The Ghaggar-Hakra or the so-called Sarasvati river, which was described as a big river in the Rig-Veda, should be divided into two; the Ghaggar in India and the Hakra in Pakistan. This finding suggests that the Indus civilization may not have been fully dependent on a big river like the other three ancient civilizations.

(3) SSRG has recovered many botanical and zoological remains from both excavated sites. At Kanmer they found the evidence of rice which had rarely been found from Mature Harappan sites. This finding suggests that the area of Kachchh may have been receiving much better precipitation during the Indus civilization than is the case today.

#### f) Future Issues

We still have to collect data relevant to the reconstruction of the palaeo-environment; i.e., sampling and analysis of the core in Kachchh for investigating climate change, taking coral samples in the Maldives and analyzing them for reconstructing the history of monsoon weather in the Indian subcontinent. Apart from this we will carry out pollen and phytolith analysis to reconstruct the vegetation of the Indus area. Therefore, we will spend our budget mainly for palaeo-environmental research in the next fiscal year.

As for the two sites in India, we will complete the excavation works by March, 2009. In the following year we will concentrate on analysing and summarizing the data, which will be integrated into GIS by the end of our project.

## 1. RESEARCH OBJECTIVES AND BACKGROUND

[Research Objectives]

Our project aims to investigate the causes of the collapse of the Indus civilization. We will study the impact of environmental change at both global and local levels, as well as other socio-cultural and historical factors, which might have caused the disintegration of networks connecting regional societies and cultures during the Mature Harappan period.

Diamond (2005) examines the causes of collapse of past civilizations and posits five possible contributing factors. They are: (1) environmental damage; (2) climate change; (3) hostile neighbours; (4) friendly trade partners; and (5) the society's responses to its environmental problems. Among them, (1) and (2) refer to local and global environmental factors, respectively, (5) to socio-cultural strategies to deal with such factors, and (3) and (4) to the influence of surrounding societies/cultures. Our project will investigate all these factors and the relationships between them which are relevant to the decline of the Indus civilization.

The first two factors, i.e., global and local environmental change during the Harappan period, will be investigated through natural scientific approach, mainly using geological methods. They include climate change at the global level, such as the change of precipitation and sea level, and local environmental changes, such as river avulsion and deforestation. The remaining three factors, i.e., the socio-cultural organizations of the Indus civilization and its historical relationships with other societies/cultures, will be investigated through humanistic approach, using archaeological, anthropological and linguistic methods. They include collection and analysis of archaeological materials excavated from important sites, ethno-botanical analysis of agricultural systems, linguistic analysis of Vedic texts and Mesopotamian cuneiform texts, etc.

By the end of our project, we will integrate the outcome of all these studies and present a possible scenario of the collapse of the Indus civilization.

#### [Background of the Indus civilization]

The Indus civilization spread over 680,000 sq. km. of northwestern South Asia. Indus people established and maintained cities like Mohenjo-daro and Harappa from 2600 BC to 1900 BC (Mature Harappan). The natural environment surrounding the archaeological sites of the Indus civilization is quite diverse. Shortughai, the northern-most site in Afghanistan, is situated in a mountainous area, while Sutkagen-dor, the western-most site in the Makran region, Pakistan, is located in a coastal area. Mohenjo-daro and Harappa are placed along the Indus river system, while Rakhigarhi, the largest site in Haryana, India, is situated on the ephemeral Ghaggar river. Thus the archaeological sites of the Indus civilization are scattered not only in the Indus valley but also in the coastal regions of Makran, Pakistan and Gujarat, India, and along the ephemeral Ghaggar-Hakra river (See Fig. 1-a).

Although it extended over such a large area, this civilization didn't have any conspicuous historical monuments like pyramids or ziggurats in other ancient civilizations. This is because the Indus civilization was not controlled under the centralization of power, but was rather a unity of diverse regional societies and cultures connected by networks. We have gradually reconstructed their characteristics as well as the networks which connected them, using various archaeological data excavated during the first two years of our project.

The downfall and disappearance of the cities like Mohenjo-daro and Harappa, reconstructed through archaeological research, have often been equated with the decline of the Indus civilization. However, as shown in the two diagrams (Fig. 1-a and 1-b) contrasting the geographical distributions of sites during the Mature Harappan and post-Harappan periods, the decline also means: (1) the shift of the concentration of archaeological sites from the surroundings of the Indus river to the northeast and the southeast, and (2) the localization or

isolation of each region. In addition, it should be noted that the sizes of the sites in the post-Harappan period tend to be much smaller than those of the Mature Harappan sites.

From these observations we assume that the decline of the Indus civilization was not a single event but a series of complex events which gradually disintegrated the networks connecting regional societies.

The most controversial issue surrounds the Ghaggar-Hakra river along which many archaeological sites of the Indus civilization are located. This river is an ephemeral river today, originating in the Sub-Himalayas and flowing through the northern part of the Thar desert. It has been identified with the river Sarasvati, which was a mighty glacier-fed river according to the description of the Rig-Veda, the oldest religious document composed in Sanskrit. The Sarasvati issue has been much discussed among the Indologists since the 19th century (Oldham 1874, 1893, Stein 1943). Recently natural scientists working in South Asia have proposed several theories about the palaeo-channel of the Ghaggar-Hakra using remote sensing, geomorphological analysis and geochemical analysis (Pal *et al.*, 1980, Prasad *et al.*, 1997, Tripathi *et al.* 2004). Scholars have not yet reached a consensus on when and how the Ghaggar-Hakra dried up.

For the last two years our palaeo-environmental research group has worked on this problem, conducting field research and analyzing high-resolution satellite images of the Ghaggar-Hakra, especially the Ghaggar. The outcome of their research suggests that the Ghaggar river was not a mighty river, but had a narrow shallow channel like today (See Fig. 2). Based on this finding we now consider that the Indus civilization, at least in this region, was not fully river-dependent as has commonly been designated, but was rather monsoon-dependent.

This Sarasvati issue has also been explored by Prof. Goto and his colleagues, members of our project, through the publication of a German translation of the Rig-Veda with detailed annotations. Thus we now have a firm basis of reassessing the Sarasvati problem through Vedic studies as well.

This hypothesis is an important one, as this may set a framework of our scenario on the process of the decline of the Indus civilization.

#### [Research background]

Previously the decline of the Indus civilization has been studied from two different perspectives.

The first group of researchers proposed that the main causes for the decline of the Indus civilization were local. There have been several different theories based on this local hypothesis — e.g. Wheeler's Aryan invasion theory (Wheeler 1947, 1968) and Raikes' flood theory (Raikes 1964, Raikes and Dales 1986). The latter theory claims that floods caused by the avulsion of the Indus river and/or deforestation were the main driving force to trigger the decline of the Indus civilization.

The second group of scholars, on the other hand, has examined the issue from the global level. They focused their study on the global climate change observed during mid- and late Holocene. They claim that the Old World, especially Asia, witnessed a collapse of agriculture-based societies including the Indus societies during mid- and late Holocene which was coincidental with an abrupt climate change (Weiss *et al.* 1993, Weiss and Bradley 2001a, b, Staubwasser and Weiss 2006, Drysdale *et al.* 2006).

The majority of Quaternary scientists representing the latter group claim that the rise and fall of the Indus civilization depended on the precipitation. They say, on the basis of the study of pollen sequences from the salt lakes of Rajasthan, that it flourished during the period of higher rainfall in the third millennium BC and declined when there was a drop in rainfall (Singh 1971, Naidu 1996, von Rad *et al.* 1999, Staubwasser *et al.* 2003). Most

archaeologists, on the other hand, are skeptical about such a claim (Misra 1984, Ratnagar 2000, Possehl 1997a, b, 1999). Possehl (1999:268), for example, considers that climate change over the past 7000 years was negligible or irrelevant for understanding past economies and social change. No consensus has yet been reached among these theories.

The past decade has seen a revival of ‘environmental determinism’ in palaeo-environmental research, with palaeo-climate shifts implicated in the collapse of many past civilizations (Coombes and Barber 2005). We do not accept the environmental determinism proposed by many scholars engaged in global-level analysis, but we also consider that it is important to integrate the outcome of palaeo-environmental research in northwestern South Asia into our project (cf. Schuldenrein (2002) and Madella & Fuller (2006)). We will examine the extent of the impact of climate change, and investigate people’s responses to it which eventually might have caused them to abandon the cities.

We especially would like to focus our research on the reconstruction of the monsoon patterns during the Harappan period, as the significance of the Indian Ocean Dipole (IOD) phenomena in relation to the monsoon in South Asia has quite recently been recognized. IOD was discovered by Prof. Yamagata and Dr. Saji and others (FRCGC), and their joint paper was published in *Nature* (Saji *et al.* 1999). These phenomena, coupled with El Niño/ Southern Oscillation (ENSO), affect the inter-annual variability of the Indian summer monsoon rainfall (ISMR) (Ashok *et al.* 2001). We will examine sea surface temperature (SST) using proxy data obtained from coral, and reconstruct the monsoon patterns during the Harappan period using the methodology of recent IOD research.

Osada, the project leader, is a specialist in Munda languages and cultures. Munda languages and cultures are considered to represent the oldest layers of those of South Asia in which three major language families are distributed. Common understanding is that the oldest layer or substratum is represented by Munda-speaking people, the second layer by Dravidian-speaking people and the newest layer by Indo-Aryan-speaking people. The Indus civilization is also often said to represent the oldest layer of South Asian cultures, but the relationship between the Indus and Munda societies and cultures is far from clear. His personal interests in this project therefore lie in investigating the characteristics of the Indus societies and cultures in comparison with those of Munda and other South Asian societies and cultures. But even without his personal interests, it would be important to apply linguistic comparative method to reconstruct the societies/cultures which might have constituted the substratum of South Asian cultures. In addition to this, he was also a student of geology, and has kept his interests in geological approach to discover the history of the Indus civilization. All these personal interests have contributed to form the basic framework of this project which focuses on the investigation into the human-environment interaction of the Indus civilization.

[Relevance of the project to environmental issues]

Although the decline of the Indus civilization seems to have been a complex process, it is clear that climate change during that period was one of the important factors which made major impact on its collapse. We assume that global climate change also affected the courses of other ancient civilizations. The investigation of the history of climate change in the Indus civilization will thus contribute to the reconstruction of the environmental histories of other civilizations.

Climate change is also a big environmental issue which will determine the future of our global

environment. Therefore it is important that we reconstruct its history using various proxy data over a large time-scale like the hundreds of years. Such data will be useful for the prediction of the future course of climate change.

[Contribution to global environmental issues]

The analysis of palaeo-environmental archives — sediments, archaeological remains, tree-rings, documents and instrumental records — is a key to the understanding of human-environment interactions at the present day and in the future. Palaeo-environmental studies are a showcase for the ‘learning from the past’, as the past, as described through palaeo-environmental studies, can yield information about pre-impact states, trajectories of recent change, causation, complex system behavior, and provide the basis for developing and testing simulation models. Learning from the past in each of these epistemological categories may be exemplified by published case studies and our present research.

We would also like to strengthen our case by adding the following points. By reconstructing climate change using coral data, we will be able to accumulate data during different periods using the same methodology. Researchers in climate change normally focus their study on a short time-scale such as a few decades; our project, on the other hand, will collect data of a much larger time-span, in the order of the hundreds of years. Such data will be very useful for predicting the future climate change of global environment.

In addition to these contributions to global environmental issues from the perspective of natural science, our research aims to contribute to the solution of the problems concerning the collapse of past civilizations in more general terms. Diamond (2005:7-8) notes: “There are some practical lessons that we could learn all the past collapse. We know that some past societies collapsed while others didn’t: what made certain societies especially vulnerable? — If we could answer these questions, we might be able to identify which societies are now most at risk, and what measures could best help them”. His point here is that past civilizations should be investigated from the perspective of human-environment interaction, i.e., how humans responded to climate change and environmental damage in the past. Only by learning the causes and processes of the collapse of the past civilizations from this perspective can our civilization find a way to survive unpredictable environmental hazards in the future. This is one of the reasons why we emphasize the perspective of human-environment interaction in our project.

## 2. SIGNIFICANCE AS AN RIHN PROJECT

Osada, leader of this project, has a linguistic background. He recognizes the difficulty of conducting research on the Indus civilization using only the methodology of humanities. It is all the more so the case if one intends to reconstruct both the natural and social environment of the Indus civilization. Obviously scholars from the backgrounds of various fields of the humanities and natural science need to cooperate to achieve the desired results, and RIHN, he believes, is one of the most appropriate research institutes in Japan for hosting an interdisciplinary project of this kind.

This is the first large-scale research project on the Indus civilization organized by a Japanese team which involves excavations of its archaeological sites. In the past there were quite a few projects on the Indus civilization and its environment organized by scholars of other countries. However, it is significant that a project of this kind is organised by scholars like us from Japan, as Japan keeps good relations with both India and Pakistan, and it is possible for us to work with scholars from both countries to cover all the important archaeological sites.

[The multidisciplinary nature of the project]

We believe that our approach is well-balanced. We have scholars from the backgrounds of both natural science and the humanities — the former mainly belonging to the palaeo-environment research group and subsistence system research group and the latter to the material culture research group and the inherited culture research group. They cooperate very well, and the research outcome of each group is expected to complement each other.

[The uniqueness of research]

This is the first time in the study on the Indus civilization that the reconstruction of monsoon patterns has been attempted; we plan to do this by utilizing results of the research on climate change related to the Indian Ocean Dipole phenomena. The project is also unique in that it attempts to investigate the characteristics of regional societies and cultures both in India and Pakistan. Thus, from the point of view of both natural science and the humanities, our project is much more comprehensive than any other previous research on this topic.

[Internationality]

We have four core members from overseas — two from India and two from Pakistan. We have been conducting archaeological and palaeo-environmental fieldwork in cooperation with these core members and other local scholars, and we are making very good progress. We also regularly organize international workshops/conferences and exchange information with scholars from US, Europe and Iran so that we can maintain the standard of our research at an international level.

[Social contribution]

In Japan we regularly organize lectures at local universities and museums. We also publish articles for newspapers and magazines so that our activities may be known not only by scholars but also by general public. We also make a social contribution outside Japan, giving lectures and training students in universities and research institutes in India and Pakistan; e.g. Maharaja Sayajirao University in Baroda, India and Shah Abdul Latif University in Khairpur, Pakistan.

### **3. RESEARCH METHODS, ORGANISATION AND PLAN**

[Change of topic/directions from the previous proposal]

In the previous proposal we set our objectives in general terms such as: investigation into the causes of the decline of the Indus civilization. However, as our project proceeds, it has become increasingly clear that the Indus civilization was a unity of diverse regional societies and cultures connected by networks. From this perspective, the collapse of the Indus civilization actually means the disintegration of such networks which connected diverse societies spreading over a very large area. Therefore this time we have changed the aim of our project to a more focused one, i.e., investigation into the causes of the disintegration of the Indus civilization networks. This does not mean that we have changed the general aim of our project, but we have rather rephrased it so that it can more aptly reflect the advanced stage of our research.

[Research methods/organization]



We have four working groups; (1) palaeo-environment research group (PERG); (2) material culture research group (MCRG); (3) subsistence system research group (SSRG); and (4) inherited culture research group (ICRG).

(1) PERG aims: (a) to investigate the palaeo-channel of the Ghaggar-Hakra river through the analysis of satellite photography and field research; (b) to reconstruct the coastline in Gujarat during the Harappan period through the analysis of satellite photography and core sampling from Lake Nal located in Gujarat; (c) to reconstruct climate change through the analysis of sea surface temperature using proxy data obtained from coral in Maldives; (d) to reconstruct environmental changes using core samplings from Lake Rara in the Sub-Himalayan region through pollen and phytolith analysis; (e) palaeo-seismological patterns for understanding the impacts of earthquakes on the Indus civilization.

(2) MCRG aims to excavate two sites in India, i.e., Kanmer and Farmana; they intend to recover cultural artefacts such as remains of Indus settlements, Indus seals, Harappan pottery, etc.

(3) SSRG aims to reconstruct the subsistence system of the Indus civilization; for this purpose they use both archaeo-botanical data found in Harappan sites, ethno-botanical data collected in field work and proxy data obtained from phytolith and pollen analysis.

(4) ICRG aims to reconstruct the Indus society using linguistic methods. Among them the Indologist subgroup analyzes Vedic and Mesopotamian cuneiform texts, while the linguistic subgroup uses linguistic comparative method to reconstruct the substratum cultures and languages in South Asia. They also have been building up a database of South Asian languages.

So far most scholars working on the archaeology of the Indus civilization have focused their study on the sites along the Indus river system; e.g., Mohenjo-daro and Harappa. Our project, on the other hand, will investigate wider contexts including the sites along the so-called lost Sarasvati (Ghaggar-Hakra) river and in the coastal area of the Kachchh district in Gujarat. Our methods used for the investigation of the lost Sarasvati are mainly geological; they include geographical analysis using high-resolution satellite imagery and remote sensing, carbon dating, analysis of thermoluminescence chronology of sand profiles in the Thar desert and core samples from lakes. We seek to establish the dating and the course of the lost Sarasvati River by applying all these latest methods. For the reconstruction of palaeo-environment of the Indus civilization, geological approaches are used to investigate tectonic movement and river avulsion. The subsistence system is studied through ethno-botanic and archaeo-botanic analysis.

For understanding the human-environment interaction we also need to collect and analyze the socio-economic and cultural data. These data help us examine human responses to environmental changes in the Indus civilization. We employ various methods of humanities to collect these data: archaeological methods to recover cultural artefacts from various sites, and linguistic and anthropological methods to discover characteristics of the Indus societies at different levels. Our archaeological teams have already excavated sites at Kanmer for three years and at Farmana for two years in collaboration with Indian archaeologists. We would like to reconstruct the socio-cultural aspects of the Indus civilization by closely examining the various aspects of material culture. Other members from the background of humanities include Indologists, linguists and cultural anthropologists. Indologists analyze the inherited cultures of the post-Harappan period based on Vedic texts, while cultural anthropologists use contemporary data. Linguists use both typological and historical-comparative methods to reconstruct the substratum languages and cultures in South Asia.

These groups work together to investigate the causes of the disintegration of the Indus civilization

networks. PERG will reconstruct the environment surrounding the Indus civilization and climate change including monsoon patterns in South Asia. SSRG attempts to reconstruct the subsistence system of the Indus civilization in collaboration with PERG, as it seems to have been very much affected by monsoon patterns. PERG will collect core samplings from lakes to obtain proxy data through pollen and phytolith analysis; they will work closely with SSRG and MCRG. MCRG will reconstruct the societies and cultures of the Indus civilization using various cultural artefacts found in archaeological sites. Their findings will be compared with post-Harappan, Vedic and modern South Asian societies and cultures described by ICRG. Sometimes members of different groups carry out joint research to benefit from each other. For example, some members of the PERG and SSRG carry out excavations together. Indologists of ICRG present their socio-cultural analysis of Vedic and Mesopotamian cuneiform texts to make a contribution to the research of other groups.

[Research plan/schedule]

Here is a summary of the research plan/schedule of our project. We are in FR2.

2006 (PR)

Whole: Organizing the project team

MCRG: Excavations at Kanmer and Farmana

2007 (FR1)

PERG: Preliminary research for the reconstruction of palaeo-environment

SSRG: Ethno-botanical research on emmer wheat; analysis of faunal and floral remains recovered from the excavated sites at Kanmer and Farmana

MCRG: Excavations in India

ICRG: Translation of Vedic texts; production of language atlas

2008 (FR2)

Whole: Organizing the international symposium 'Cultural relations between the Indus and the Iranian Plateau during the third millennium BC'

PERG: Preliminary research for the reconstruction of palaeo-environment

SSRG: Ethno-botanical research on emmer wheat; analysis of faunal and floral remains

MCRG: Excavations in India

ICRG: Publication of the translated/annotated Vedic texts; production of language atlas

2009 (FR3)

Whole: Organizing an international symposium on the reconstruction of Indus networks.

PERG: Boring survey in Lake Rara for the reconstruction of the global palaeo-environment; boring survey in Kachchh for the reconstruction of the local palaeo-environment.

SSRG: Ethno-botanical and archaeo-botanical research.

MCRG: Reconstruction of networks on the basis of the analysis of remains; data collection in Pakistan; Completion of archaeological database.

ICRG: Publication of the translated/annotated Vedic texts; publication of language atlas

2010 (FR4)

Whole: Organizing an international symposium to synthesize the research outcome of the four groups.

PERG: Completion of the reconstruction of the palaeo-environment during the Indus period.

SSRG: Reconstruction of subsistence system based on the outcome of the ethno-botanical and archaeological research.

MCRG: Reconstruction of networks on the basis of the analysis of remains; data collection in Pakistan; Completion of archaeological database.

ICRG: Publication of the translated/annotated Vedic texts; publication of basic materials of South Asian languages.

2011 (FR5)

Whole: Synthesizing the results of the four research groups; publication of the final outcome of the project.

#### 4. POLICIES REGARDING HUMAN-RIGHTS AND SECURITY FEATURES

Needless to say, we need to abide laws for protection of cultural properties with regard to the results of excavations in India and Pakistan. In addition, it is important to respect the customs and cultural practices of the two countries and make sure that there is no misunderstanding with each other. In the case of official processes we keep close contact with the Archaeological Survey of India (ASI) and the Department of Archaeology, Pakistan (DAP). Since the political situation in Pakistan and India is not stable, we try to gather first-hand information on the safety of the areas where field work is conducted from our local counterpart and directly from project members if there are some in the field.

#### 5. OUTCOMES UP TO NOW

##### a) Outcomes of the project as a whole

So far we have achieved three major findings, one each from the work of MCRG, PERG and SSRG.

(1) MCRG found that there are both similarities and differences in the artefacts of the two regions where they have excavated. This seems to suggest the existence of strong regional differences as well as trading and other kinds of networks which united them. It is due to this finding that we have rephrased the objective of our project. The artefacts found from both excavated sites which show similarities include: Indus seals with Indus script, Harappan pottery, several kinds of beads made from carnelian, steatite, faience, lapis lazuli etc. Significant difference, on the other hand, is observed in construction materials; i.e., at Kanmer we find local stone-made constructions, while at Farmana there are sun-dried brick-made constructions. In addition, we observe the existence of different kinds of local pottery at each site.

(2) PERG found that the Ghaggar seems to have been rather a small river easily affected by the quantity of rainfall in the monsoon season. The Ghaggar-Hakra or the so-called Sarasvati river, which was described as a big river in the Rig-Veda, should be divided into two; The Ghaggar in India and The Hakra in Pakistan. This finding suggests that the Indus civilization may not have been fully dependent on a big river like the other three ancient civilizations.

(3) SSRG has recovered many botanical and zoological remains from both excavated sites. At Kanmer they found the evidence of rice which had rarely been found from Mature Harappan sites. This finding suggests that the area of Kachchh may have been receiving much better precipitation during the Indus civilization than is the case today.

We published four volumes of Occasional Papers in 2008. The main contents of each volume are as follows:

Volume 3 (on the spread of textile crop by Fuller; on archaeological discoveries in Sindh, Pakistan, by Mallah, a report of exploration in the Ghaggar basin and excavations at Farmana, etc. by Shinde *et al.*, etc.)

Volume 4 (a report of surface analysis of archaeological site in Sindh by Mallah, a report of excavation at Jaidak, Gujarat by Ajithprasad, etc.)

Volume 5 (reports of the second season excavation at Kanmer by Kharakwal *et al.*, Goyal *et al.* and Teramura *et al.*, including a report of a geomorphological survey by Rajaguru *et al.*, etc.)

Volume 6 (A report on Excavations at Farmana 2007-08 by Shinde *et al.*)

#### b) Results of each work group

##### [MCRG]

MCRG members achieved good results from excavations in Kanmer and Farmana in 2006 and 2007. Their discoveries in Kanmer include a pendant with Indus sealing and script which has rarely been found in the previous excavations at Mature Harappan sites, a furnace for making accessories, and a citadel with rock walls; those in Farmana include buildings made of sun-dried bricks and a cemetery with human bones. They have also found six Indus seals and sealings in total at both sites. As mentioned in 5-a), we can observe similarities and differences in the cultures of these regions behind these artefacts.

The site of Farmana is one of the few Harappan sites that have a Mature Harappan cemetery. There are three types of burials in Farmana: primary, secondary and symbolic. They buried the dead either in north-south or northwest-southeast direction. Such variations in their customs clearly suggest the presence of different population groups within Farmana.

The archaeology-GIS team has been digitalizing and analyzing all the archaeological data pertaining to the Indus civilization at different analytical scales, ranging from macro levels to micro levels, with the aid of Geographic Information System (GIS).

We have already published reports of the first and second seasons of excavations at Kanmer (Kharakwal *et al.* 2007, 2008) and Farmana (Shinde *et al.* 2008, Shinde *et al.* 2008). A report on the work of GIS group (Teramura *et al.* 2008) has also been published.

##### [PERG]

PERG conducted preliminary field research in 2007 to collect data for the reconstruction of the ancient channel of the Ghaggar-Hakra river, or the so-called lost Sarasvati. They also examined aerial photos of the northwestern part of India to trace the river channel (Fig. 2). Their tentative conclusion at this stage, as mentioned above, is that the Ghaggar river was not a big river which could create substantial flooding. As is well-known, agriculture in South Asia is largely dependent on the monsoon. There are two crops per year — kharif (summer crop) and rabi (winter crop) — and this type of agriculture seems to have been also common in the Indus civilization. Another finding of the palaeo-environmental research conducted by Dr. Okuno is that the level of the coastline in Gujarat during the Harappan period was two meters higher than the current sea level (Fig. 3). From this we consider that

most of the Harappan sites in Kachchh were on the border of the Arabian Sea at that time.

Dr. Rajaguru has been conducting geomorphological survey around Kanmer for PERG. His preliminary survey indicates that the water levels were higher during the mid-Holocene, but it dried up after 2000 BP creating the current landscapes of Kachchh (Rajaguru and Deo 2008). This matches the result of Dr. Okuno's work.

The Indian Ocean Dipole phenomena mentioned in (3) above play an important role as a modulator of the Indian monsoon rainfall and influences the correlation between the Indian summer monsoon rainfall and the El Niño/ Southern Oscillation. Dr. Yokoyama, a member of our project, has collected coral data from Maldives. Although he has not yet found data contemporary with the Indus civilization we hope he will eventually reconstruct the sea surface temperature during the Indus period through oxygen isotope thermometry.

#### [SSRG]

SSRG led by Dr. Ohta conducted fieldwork in South India in 2007 and 2008. They have established the geographical distribution of the cultivation and the domestic use of emmer wheat. They plan to continue investigating the distribution of various crop plants in South Asia. Dr. Weber, experienced in Harappan archaeo-botanical study since 1980s, intends to analyze floral remains at Farmana. However, the laboratory analysis of grains is still waiting. Dr. Pokharia, a member of our project, has done some analysis of grains recovered from Kanmer.

At Kanmer we have collected floral samples such as barley, bread-wheat, dwarf-wheat, rice, sorghum, and pearl-millet by using a floatation method; faunal samples collected include mammals, birds, reptiles, fish and a couple of molluscan species. Eight species of domestic mammals such as cattle, buffalo and sheep, etc. and fifteen of wild mammals such as nilgai, antelopes and deer were found in the first two seasons, i.e. 2005-06 and 2006-07. The evidence of rice from Kanmer strongly suggests that the area of Kachchh may have been receiving much better precipitation during Harappan times than today.

At Farmana we have collected floral samples such as wheat, barley and rice grains but laboratory analysis of the grains is not yet possible at this stage; the faunal samples include domestic mammals such as cattle, buffalo, sheep, goat, and pig and wild mammals such as wild pigs, gazelle, antelope, and nilgai.

#### [ICRG]

Dr. Goto, a core member of our project, published the first volume of the German translation of the Rig-Veda with detailed annotations (Witzel *et al.* 2007). The linguistic subgroup has produced the first version of a language atlas which represents the current linguistic situation in South Asia. These materials are very important for us to understand the societies and cultures of the post-Harappan periods; they also supply basic data for deciphering the Indus script and reconstructing the substratum languages and cultures in South Asia.

#### c) Problems and possible solutions

In the initial stage we selected three archaeological sites to understand the differences and similarities in various regions of the Indus civilization. Between the northern site situated at Farmana and the southern site located at Kanmer, we selected the third one — Ganweriwala in the Cholistan desert region in Pakistan. We had planned to excavate at Ganweriwala in 2008, but we had to abandon the plan due to the political situation in Pakistan.

We have sought for an alternative and negotiated with the archaeologists at Shah Abdul Latif University in Khaipur. We now plan to excavate a site in Sindh jointly with them in the next season.

SSRG intends to conduct DNA analysis of emmer wheat but at present it is very difficult to get samples for such analysis. Grain samples cannot be brought to Japan due to the Indian laws. We need to collaborate with Indian geneticists for this purpose. Dr. Kawase, a member of our project, is negotiating with some Indian officials to get permission on this matter.

d) Past grants and funds related to the project

Grant-in-Aid for Scientific Research (C) 1998-2000

Project number 10616527

A preliminary study of the Munda etymological dictionary, by T. Osada.

Grant-in-Aid for Scientific Research (C) 2001-2003

Project number 13610650

The construction of database to compile the Munda etymological dictionary, by T. Osada.

The aims of these projects were to understand the Munda languages and cultures which constitute the substratum of South Asian languages and cultures. The outcome of these research projects led Osada to conduct this project on the Indus civilization which is considered to represent the substratum societies and cultures in South Asia.

## 6. RESPONSE TO THE COMMENTS

Our responses to the comments made by the Evaluation Committee in the progress report in 2007 are as follows:

### (1) Interdisciplinary approach

PERG was not fully operating in March, 2007 but now they are very active. They have done preliminary field research on the Ghaggar-Hakra, especially the Ghaggar, and the coastal area of Gujarat. They have selected boring spots in Kachchh and in the Sub-Himalaya region to collect core samples. They have collected coral data which will be used to reconstruct sea surface temperature through oxygen isotope thermometry. This reconstruction will help us understand the monsoon patterns during the Harappan period. PERG aims to reconstruct the natural environment surrounding the Indus civilization and climate change including monsoon patterns in South Asia.

The subsistence system of the Indus civilization seems to have been heavily affected by the monsoon patterns which will be reconstructed by PERG. PERG will collect core samplings from lakes to obtain proxy data through pollen and phytolith analysis; they will work in collaboration with SSRG and MCRG. MCRG aims to investigate social organizations of the Indus civilization using archaeological data. They also compare their findings with Vedic societies and modern South Asian societies reconstructed by ICRG.

Sometimes members of different groups carry out joint research to benefit from each other's work. This year some members of PERG and SSRG carry out excavation work jointly at the two sites. ICRG has provided other groups with their socio-cultural analysis of Vedic texts.

### (2) Sarasvati

One of the major findings of PERG is that the Ghaggar does not seem to have been a big river as previously designated following the description of the Sarasvati in the Rig-Veda. They have already collected twelve samples which will be used for the analysis of thermoluminescence chronology of sand profiles along the Ghaggar river. The forthcoming result of this analysis will be important for the dating of the drying up of the Ghaggar.

### (3) Subsistence system

As mention in (1) we will collect core samples in February, 2009. Pollen and phytolith analysis will be carried out on these samples. The forthcoming result of the analysis will reveal the vegetation which is relevant to the subsistence system of the Indus civilization. In addition to this, Dr. Weber of Washington State University, a member of our project, will write a book based on his long experience in archaeo-botanical research in South Asia. This will become a major contribution to the reconstruction of the subsistence system of the Indus civilization.

(4) Climate change

The Indian Ocean Dipole phenomena mentioned in 3 play an important role as a modulator of the Indian monsoon rainfall and influences the correlation between the Indian summer monsoon rainfall and the El Niño/Southern Oscillation. Dr. Yokoyama, a member of our project, has collected coral data for the reconstruction of sea surface temperature through oxygen isotope thermometry. It is the first time in the history of research on the Indus civilization that researchers use this kind of data to reconstruct monsoon patterns during the Harappan period. The result of this research is expected to be significant not only for Quaternary scientists but also for archaeologists working on the Indus civilization.

In addition to the reconstruction of this kind of global climate change, we can also reconstruct local environmental changes during the period through the analysis of the core samplings.

## 7. FUTURE ACTIVITIES

a) Research objectives until the next evaluation meeting

[PERG]

Future activities of PERG include:

- (1) reconstruction of the Ghaggar-Hakra river by using remote sensing, high-resolution satellite imagery and other data from field research; this will help us understand the role of the Ghaggar-Hakra in the Indus civilization;
- (2) collecting and analyzing core samples at Rara lake to examine local environmental changes;
- (3) core sampling at Kachchh and pollen and phytolith analysis in collaboration with SSRG to reconstruct the vegetation patterns in the region;
- (4) analysis of coral samples collected and to be collected in Maldives and/or Lakshadweep to reconstruct the monsoon patterns during the Harappan period;
- (5) palaeo-seismological survey in Pakistan and India to assess the impact of earthquakes on the Indus civilization.

[MCRG]

Excavations at Kanmer and Farmana sites will be completed by the end of this fiscal year. They will analyze collected data including artefacts such as seals, sealings, pottery and beads, and carbon 14 dating. We will integrate all the analysed data into GIS. Their research is important to understand the characteristics of the regional societies and cultures and the networks which connected them.

[SSRG]

Dr. Weber will publish, on behalf of our project, a book on the subsistence system of the Indus civilization based on his long-standing archaeo-botanical research in South Asia since 1980s. This monumental work will make a tremendous contribution to our project, as this will help achieve one of our aims, i.e., the reconstruction of the subsistence system of the Indus civilization. In addition, the palaeo-ethnobotany subgroup led by Dr. Ohta will

present a hypothesis on the conditions of agriculture in the Indus civilization.

[ICRG]

ICRG led by Dr. Goto will supply data on the Sarasvati described in Vedic texts to other research groups. In addition to the research on this specific topic, research on the Indus societies and cultures in comparison with the ones in the Vedic period is also being carried out by this group. The outcome of this research will be published by the end of our project. The linguistic subgroup within ICRG led by Dr. Onishi will publish books on the current linguistic situation of South Asia. This includes a linguistic map of South Asia and grammars of selected South Asian languages. These works will contribute to our understanding of the substratum languages and cultures in South Asia which will be utilized for the decipherment of the Indus script.

b) Plans until the beginning of the new fiscal year

Excavations at Kanmer and Farmana started in December, 2008 and will be completed by mid-March, 2009. Excavations at Kanmer are being conducted by a team led by Dr. Kharakwal, a core member of our project. In this season they aim to establish the internal structure of the citadel including the discovery of the supposed gates of the citadel. The main purpose of the excavation at Farmana led by Dr. Shinde, another core member of our project, is to find out how and when the town structure and cemetery were constructed.

In addition to these excavations, topographic survey, digital photogrammetry of the architectural remains and GPR (Ground Penetrating Rader) survey will be carried out by Dr. Uno, another core member, and his team at both sites. Dr. Saitou, a physical anthropologist, will study human bones at the cemetery at Farmana in February, 2009. Archaeo-botanical research will be conducted by Dr. Pokharia at Kanmer and by Dr. Weber at Farmana. Archaeo-zoological research will be carried out by Dr. Joglekar and his team at both sites.

PERG will obtain core samplings by boring near Kanmer in February, 2009, collaborating with an MS University team led by Dr. Chamyal. The analysis of the core samples will be carried out by Dr. Miyauchi, a member of our project.

We held an international symposium entitled: 'Cultural relations between the Indus and the Iranian plateau during the third millennium BC' in June, 2008. A collection of papers read in this international symposium will be published from the Department of Sanskrit and Indian Studies, Harvard University by the beginning of the next fiscal year. Professor Michael Witzel of Harvard University has agreed to publish it.

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