



EVALUATION REPORT

On the Performance of the Regional Training and Research Center on Ocean Dynamics and Climate

May 2015 - May 2020

TABLE OF CONTENTS

1.	Introduction	3
2.	Background	3
3.	A brief about RTRC-ODC's activities in 2015-2020	4
4.	Evaluation results	6
5.	The RTRC-ODC's future plan for May 2020 - May 2025	7
6.	Conclusion and recommendation	7

Annexes

I.	Proposed work plan of annual training activities (2021-2025)	8
II.	Some queries and answers concerning the outputs and outcomes from the RTRC-ODC trainings	10

1. Introduction

The purpose of this evaluation is to facilitate the consideration of renewing the Agreement, through an exchange of letters, between the Intergovernmental Oceanographic Commission of UNESCO (IOC/UNESCO) and the First Institute of Oceanography (FIO) of the Ministry of Natural Resources, P.R. China, regarding the establishment of a Regional Training and Research Center participating in the UNESCO/IOC Regional Network of Training and Research Centers on Marine Science in the Western Pacific. The Agreement was signed by both parties in May 2010, and renewed every five years. The last renewal was done in May 2015.

This evaluation was conducted by the IOC Sub-Commission for the Western Pacific (WESTPAC) in cooperation with the National Committee of China for IOC/UNESCO, on the performance of the Regional Training and Research Center on Ocean Dynamics and Climate (RTRC-ODC) for the period May 2015- May 2020, in considerations of the need to maintain the momentum established over the last ten years in serving the capacity development needs of IOC Member States particularly in the region and beyond, the implementation of the IOC/UNESCO Capacity Development Strategy (2015-2021), and the UN Decade of Ocean Science for Sustainable Development (2021-2030).

The evaluation was conducted mainly around: i. whether the RTRC makes an important contribution to the High-Level Objectives of IOC/UNESCO and its Sub-Commission for the Western Pacific; ii. whether the proposed schedule of major activities has been effectively pursued; and iii. outputs, outcomes and sustainability of RTRC-ODC activities.

The RTRC-ODC submitted written reports and presented its activity implementation, and received regular review and suggestions of IOC Member States in the region at the WESTPAC intergovernmental sessions. The feedbacks concerning the RTRC effectiveness and efficiency were sought from RTRC trainees, research partners and IOC Member States. In addition, during the evaluation process, some prominent enquires were raised concerning the outcomes of RTRC-ODC activities, with detailed clarifications made that could be found in **Annex II**.

2. Background

Capacity development is one of core functions of the IOC/UNESCO and serves as the primary catalyst through which IOC will achieve its missions and objectives.

‘IOC has a long tradition of capacity development coordination and implementation through its Sub-Commissions and Regional Committees’¹. Following up on the IOC Principles and Strategy for Capacity Building (IOC/INF-1211, adopted at the 23rd Session of IOC Assembly, 21–30 June 2005) and its concept of ‘self-directed capacity-building’ that leads to autonomous development cycles, the IOC Sub-Commission for the Western Pacific (WESTPAC) established a region specific capacity development programme entitled ‘[IOC Regional Network of Training and Research Centers \(RTRCs\) on Marine Science](#)’ at its seventh Intergovernmental Session (IOC/SC-WESTPAC-VII/3s, Sabah, Malaysia, 26-29 May 2008).

The initiative aims to improve and sustain national and regional research capacity of IOC Member States in the region that are vital to sustainable development, through the establishment of Regional Training and Research Centers (RTRCs) in national oceanographic institutes or universities, and provision of regular training and research opportunities in RTRCs on their specialized areas to young scientists mainly from developing countries particularly in the region.

¹ Page 27, IOC Capacity Development Strategy (2015-2021).

Since its establishment, the RTRC network has been co-developed and co-implemented with Member States in the region. It builds on Member States' strong ownerships and the host institutions' widely recognized areas of specialization, cross-fertilizes the global-wide knowledge and expertise, links training closely to research, and suits national and regional priorities for ocean sustainability.

Global warming is unequivocal as a result of escalating human activities, and the ocean plays a central role in regulating the Earth's climate. In response to the increasing demand for enhancing research capacity on ocean dynamics, air-sea interaction and numerical modeling, the Sub-Commission initiated region-wide consultations and technical evaluation, and finally established the Regional Training and Research Center on Ocean Dynamic and Climate (RTRC-ODC) at the 8th WESTPAC Intergovernmental Session ([IOC/SC-WESTPAC-VIII/3s](#), Recommendation SC-WESTPAC-VIII.2, Bali, Indonesia, 10-13 May 2010). The RTRC-ODC was established at the First Institute of Oceanography (FIO), Ministry of Natural Resources, P.R. China, in light of its widely recognized scientific and technical specialization in ocean dynamics and climate research, especially ocean and climate model development.

The objective of the RTRC-ODC is to enhance national and regional research capacity on ocean dynamics, air-sea interactions, climate change and numerical modeling. The Agreement was renewed once in May 2015 at the 10th WESTPAC Intergovernmental Session (Phuket, Thailand, 12-15 May 2015), upon Member States' satisfaction over the RTRC-ODC's scientific and technical competence, and the fulfillment of its committed activities. The renewal was made through an exchange of letters between IOC/UNESCO and FIO, including a proposed RTRC-ODC's training plan for 2015-2020.

3. A brief about RTRC-ODC's activities in 2015-2020

In accordance with the renewed Agreement, FIO with the support of the Government of China, fully fulfilled its commitment to RTRC-ODC for 2015-2020², having effectively conducted planned activities as an integral part of the international cooperative framework in the region.

Throughout the activity implementation, the RTRC-ODC has been informing and inviting all IOC Member States in the region to identify suitable candidates, reporting its activities to and receiving guidance from Member States in the region. While its detailed reports to each WESTPAC Intergovernmental Session could be found at the WESTPAC website, the following provides a snapshot of RTRC-ODC's key activities mainly conducted in 2015-2020.

3.1 Training activities

Since its inauguration in 2011, 9 international trainings have been developed and provided annually to young scientists mainly from developing countries within and outside the region. **A total of 841 applications from 54 countries were received, with 395 young scientists from 43 countries finally selected for the 9 training courses. Specifically, in the evaluation period of 2015-2019, 578 applications were received from 46 countries, and 191 young scientists from 36 countries were finally selected.**

The RTRC-ODC has **established and kept enriching a pool of resource experts** to regularly support the annual trainings and joint research activities. A total of 40 international experts from 10 countries were invited to lecture and supervise trainings in the past 5 years, including those from China (16), USA (12), France (3), Italy (2), Germany (2), Australia (1), UK (1), Argentina (1), Japan (1), and Ukraine (1).

² The scheduled international training in 2020 had to be postponed to 2021, due to the Covid-19 pandemic.

The RTRC-ODC trainings were tailored to suit young scientists' needs, covering a series of subjects ranging from ocean models (2011), ocean dynamics (2012), air-sea interaction and modeling (2013), climate models (2014), climate change (2015), ocean dynamics and multi-scales interaction (2016), development of coupled regional ocean models (2017), ocean forecast system (2018) and climate dynamics and air-sea interactions (2019). The RTRC-ODC training 2020, originally scheduled for 13-22 July 2020, on the application of coupled climate models had to be postponed to 2021 due to the COVID-19 pandemic.

The importance of hands-on exercise can never be overemphasized. In addition to a series of lectures, the RTRC-ODC trainings featured hands-on exercises by virtue of its well-equipped computer systems, software and super-computer resource. **For each training course, one third of the training time has been dedicated to hands-on exercises.** Meanwhile, workshops and group discussions in different forms constitute another integral part of each training to assist trainees in deepening their knowledge, and developing their spirits of teamwork and cooperation. "A high level of enthusiasm for interactions among experts and trainees has been pervasive throughout the training period, resulting in a series of wonderful reports and creative posters from trainees to show their achievements" (*Tal Ezer, 2019*).

To sustain the capacity of trainees, the Center also keeps in contact with most trainees after their attendance to training courses, assisting their research and developing scientific publications. For instance, with the knowledge acquired and assistance provided, Mohd Fadzil Mohd Akhir's research group in Malaysia published several papers on the upwelling systems, tropical cyclones and internal tide in SEA region over the past 5 years, Mir Kashem from Bangladesh published a paper on air-sea interaction in 2019. **The reference list of published papers could be found as Q2/A2 in Annex II.**

3.2 Research activities

In line with the Sub-Commission's main principles for capacity development, the RTRC-ODC has been linking training closely with research, by offering research opportunities for early career professionals on ocean modeling, regional climate prediction and ocean forecasting system development. Several selected early career professionals were provided with sponsorships and worked in the Center. Those include: Akila Harishchandra and Kashmila Madusha Samankumari from Sri Lanka on regional ocean modeling in 2017, Ernest Kok from Malaysia on the establishment of regional OFS in 2018, Getachew Mehabie Mulualem from Ethiopia on the seasonal climate prediction in 2018, and Sangmanee Chalermrat from Thailand on ocean modeling and forecasting in 2019.

It is noteworthy that RTRC-ODC and its trainees especially from Thailand and Malaysia have been actively engaged in the development of a SEAGOOS Ocean Forecasting System (OFS) which was launched by the Sub-Commission in 2012 as a demonstration system, and further developed into a fully operational system since 2018. The OFS products can be easily accessed via both the website³ and Mobile App "Global Ocean On Desk" (GOOD).

With a view to broadening early career professionals' scope of knowledge, the RTRC-ODC also synergized its efforts with other relevant international programmes for interactions with the world's leading scientists. In cooperation with WCRP/CLIVAR, the 8th RTRC-ODC annual training course in 2018 was organized back to back with the CLIVAR-FIO Joint Summer School on "Past, Present and Future Sea Level Changes".⁴

³ <http://221.215.61.118:2018/#/>

⁴ <http://www.clivar.org/events/clivar-fio-joint-summer-school-2018>

4. Evaluation results

The Sub-Commission considered that FIO has effectively pursued its committed activities for 2015-2020, and made a great contribution to the achievement of the **IOC High-Level Objective: Increased resiliency to climate change and variability and the WESTPAC's priority interests, and the Sub-Commission's key thematic area of actions: Ocean processes and climate change.**

The visibility of IOC/UNESCO was greatly enhanced for this region, through the development of the RTRC network and provision of regular training and research opportunities by the RTRC-ODC. The IOC Member States in the region highly appreciated the great contribution of the RTRC-ODC, in the past ten years, to developing/enhancing national/regional research capacity and transferring marine technology on ocean dynamics and climate, especially on ocean and climate modeling.

This could be demonstrated by the increased capacity of IOC Member States in the region, such as Thailand and Malaysia for developing operational ocean forecasting systems to serve their needs for ocean management, marine biodiversity conservation, search and rescue. For instance, responding rapidly to a ferry accident of 5 July 2018 in Thailand, Thailand used OFS (<http://110.49.56.166/thailand/results.jsp>) to provide a series of ocean forecasts for the wreck site and adjacent areas, which proved a great value in supporting the ensuing search and rescue operations.

The RTRC-ODC plays an active role in ensuring that the developed capacity could be sustainable. Particular attention has been paid to **linking its activities closely to international research programmes** such as the Sub-Commission initiated SEAGOOS Ocean Forecasting System (OFS) and Monsoon Onset Monitoring and its Social-economic Impacts (MOMSEI). In addition to assisting improving national and regional capacity for ocean dynamics and climate, the RTRC-ODC has been instrumental for the Sub-Commission in developing **an early career professional network** on ocean climate and dynamics. The initial network is expected to be further enlarged and strengthened for the region, particularly in the context of the UN Ocean Science Decade.

Thanks to the host institutions, the First Institute of Oceanography and the Ministry of Natural Resources, P.R. China, **financial sustainability had been ensured** for the operation and majority of the expenditure for the ODC trainings and research opportunities.

The RTRC initiative has been recognized as one best practice in the region for capacity development and transfer of marine technology, as expressed by many Members States at various occasions, such as the WESTPAC Intergovernmental Sessions, IOC governing bodies sessions, and the recent [UN Ocean Science Decade Regional Workshop for North Pacific and Western Pacific Marginal Seas](#) (31 July-2 August 2020, Tokyo, Japan)⁵.

In the context of the UN Ocean Conference and to assist Member States in achieving the SDG 14: Life below water, the RTRC initiative and RTRC-ODC has been made as an voluntary commitment to [“Develop research capacity and transfer of marine technology through the UNESCO/IOC Regional Network of Training and Research Centers \(RTRCs\) on Marine Science in the Western Pacific and adjacent regions in support of the SDG 14.a”](#)⁶.

The support by Member States for the operation of RTRC-ODC and its activities proved that the RTRC initiative provides a suitable tool, in particular for the region, to assist Member States in developing and sustaining the necessary capacity to undertake activities necessary to achieve the IOC vision and objectives at the national level as well as at the international cooperation level.

⁵https://www.oceandecade.org/assets/uploads/documents/Summary-for-the-NPWPMS-WS-final_1573812940.pdf

⁶ <https://oceanconference.un.org/commitments/?id=15266>

5. The RTRC-ODC's future plan for May 2020 - May 2025

Once the Agreement is renewed, FIO and the RTRC-ODC will continue fulfilling its commitment to supporting the IOC and UNESCO mission, and further delivering its services and assisting IOC Member States to achieve the sustainable development of oceans, coasts and marine resources.

The key areas of actions that the RTRC-ODC will focus on for its next five years (May 2020-May 2025) were proposed below, taking into account the suggestions from the scientific communities and IOC Member States at various occasions. The tentative workplan includes, but not limited to, the following activities.

- Conduct the annual international trainings with details provided in the **Annex I**, as part of the Sub-Commission's contribution to the UN Decade of Ocean Sciences for Sustainable Development;
- Offer "On-the-Job Training" opportunities for selected young researchers mainly from the developing countries, explore the possibility of jointly granting degrees such as PhD with universities, and **strengthen and scale up a network of early career professionals on ocean dynamics and climate**;
- Improve modelling and prediction capabilities on ocean, Typhoon and climate, and deliver relevant and timely societal services, through: i. maintain and extend the services of OFS; ii develop coupled (atmosphere-ocean-wave-land-ice) climate models for simulation, and for monthly to seasonal predictions; iii. develop physical-biogeochemical model with ocean data assimilation;
- Keep engaging in the ongoing and coming international cooperation programmes or initiatives, particularly the SEAGOOS Ocean Forecasting System development and its applications, and the UN Decade of ocean Science for Sustainable Development.

6. Conclusion and recommendation

The Sub-Commission considered that the host institute, FIO has completely fulfilled its commitment over the last five years as specified in the Agreement between IOC/UNESCO and FIO.

The Sub-Commission would like to acknowledge the significant contribution of FIO and the Ministry of Natural Resources, P.R. China to the efficient operation of RTRC-ODC and the conduct of all planned trainings and research activities. In particular, their tremendous efforts in securing the long-term sustainability of RTRC-ODC for the benefit of IOC Member States are highly commendable.

Built on FIO's specialized areas, facilities and human resources, the RTRC-ODC regular trainings and research opportunities focus on ocean dynamics and climate, air-sea interactions and model development, which greatly assisted developing countries particularly in the region, in developing their research capacity for ocean and climate and numerical modelling. There are numerous feedbacks received from Member States, trainees and lectures that can prove the quality, outcomes and even impacts of these activities.

Therefore, the Sub-Commission would like to recommend that the Agreement be renewed between IOC/UNESCO and FIO, for the next five years to ensure a continued contribution of the RTRC-ODC to the implementation of the IOC Capacity Development Strategy and the coming UN Decade of Ocean Science for Sustainable Development (2021-2030).

Annex I:

Proposed annual training activities (2021-2025)

2021: Regional application of coupled climate models	
Main topics:	<p>Basic courses: Theory of regional air-sea interactions;</p> <p>Advanced courses: Coupling processes of atmosphere, ocean circulation, surface wave, sea ice and land surface; development and application of coupled regional climate models</p> <p>Applied courses: Climate data assimilation, Typhoon/monsoon and their responses to the climate, practice of regional coupled regional climate models</p>
Timing:	Two weeks, with 2-5 lectures for each topic
Expected outcomes:	Deep understanding on regional climate model. and practice on numerical simulation of regional climate.

2022: Application of ocean forecast system	
Main topics:	<p>Basic courses: High resolution ocean models in global and coastal regions, simulation of the circulation, tide and surface wave in coastal regions and their coupling, ocean forecast system and the interpretations/applications of forecast results.</p> <p>Frontier lectures: Applications of ocean forecast system in supporting sustainable development</p> <p>Practical exercises: Analysis and application of the results from ocean forecast system</p>
Timing:	Two weeks
Expected outcomes:	Deep understanding on the coupling of ocean surface wave, circulation and tide and practice application of ocean forecasting system in coastal region.

2023: Climate prediction and projection	
Main topics:	<p>Basic courses: Dynamics/Causes of climate variability, prediction and projection of climate, Evaluation of climate models, climate dynamics in tropical and mid-latitude regions</p> <p>Frontier lectures: New findings from the new version Assessment Reports (AR6) of the United Nations Intergovernmental Panel on Climate Change (IPCC).</p> <p>Practical exercises: Diagnosis of earth system models</p>
Timing:	Two weeks: 2-4 lectures within one week, and another week for summer school
Expected outcomes:	Deep understanding of the climate variability and change, diagnosis of the earth system models

2024: Ocean ecosystem modeling	
Main topics:	<p>Basic courses: Basic dynamics of ocean circulation, surface wave, tide and mesoscale of open ocean and shelf regions, multi-processes coupling in ocean models, and numerical marine ecosystems.</p> <p>Frontier lectures: Coupling of ocean dynamic and biochemical processes, simulation of marine environment in global and coastal regions.</p> <p>Practical exercises: Setup and running the ocean-tide-wave coupled model in coastal region</p>
Timing:	2-4 lectures within one week, with a back to back one-week summer school
Expected outcomes:	Understanding on the ocean dynamics and implementation in numerical models

2025: Data assimilation in ocean models	
Main topics:	<p><u>Basic courses</u>: Basic theory and principles of data assimilation, ensemble Kalman filter, 3-dimensional variational data assimilation method, data assimilation systems for operational ocean forecast system</p> <p><u>Frontier lectures</u>: Data assimilation methods and their applications</p> <p><u>Practical exercises</u>: Data assimilation experiments in regional and global ocean models</p>
Timing:	Two weeks
Expected outcomes:	Deep understanding on the data assimilation in ocean models

Annex II: Some queries and answers concerning the outputs and outcomes from the RTRC-ODC activities

Q1: What is the number of a total of applicants? It is good too if we can know how many from outside the region

A1: From the year 2011 to 2019, the RTRC-ODC has received a total of 841 applications from 54 countries, including 578 from 46 countries during the evaluation period of 2015-2019. The following two forms are the distribution of applicants and participants in the WESTPAC and beyond the region during the past 5 years. The detailed information is as follows.

1) Applications

Region	2015	2016	2017	2018	2019	Total
WESTPAC	42	58	58	83	87	328
OUTSIDE	13	23	27	123	64	250

2) Selected

Region	2015	2016	2017	2018	2019	Total
WESTPAC	27	27	27	29	25	135
OUTSIDE	8	10	9	18	11	56

191 trainees from 36 countries in the evaluation period.

Q2: It is better to show the references of these papers published by trainees after they received trainings and conducted joint research

A2: The following are some of the papers published by Mohd Fadzil Mohd Akhir's research group over the past 5 years:

- 1) Che Din Mohd Safuan, Nur Hidayah Roseli, Zainudin Bachok, Mohd Fadzil Mohd Akhir, Changshui Xia, Fangli Qiao, 2020, First record of tropical storm (Pabuk - January 2019) damage on shallow water reef in Pulau Bidong, south of South China Sea. *Regional Studies in Marine Science*, 35, <https://doi.org/10.1016/j.rsma.2020.101216>.
- 2) Kok Poh Heng, Akhir Mohd Fadzil, Fangli Qiao, 2019, Distinctive characteristics of upwelling along the Peninsular Malaysia's east coast during 2009/10 and 2015/16 El Ninos. *Continental Shelf Research*, 184: 10-20, <https://doi.org/10.1016/j.csr.2019.07.004>.
- 3) Daud Nurul Rabitah, Akhir Mohd Fadzil, M muslim Aidy, 2019, Dynamic of ENSO towards upwelling and thermal front zone in the east coast of Peninsular Malaysia. *Acta Oceanologica Sinica*, 38(1): 48-60. <https://link.springer.com/article/10.1007/s13131-019-1369-7>
- 4) Hidayah, Roseli, Mohd, et al., 2019, Temperature variability caused by internal tides in the coastal waters of east coast of Peninsular Malaysia. *Acta Oceanologica Sinica*, 38(1): 22-31. <https://link.springer.com/article/10.1007/s13131-019-1367-9>
- 5) Zuraini Zainol, Mohd Fadzil Akhir, 2016, Coastal upwelling in the vicinity of Tioman Island. *Journal of Sustainability Science and Management, Special Issue Number 1: The International Seminar on the Straits of Malacca and the South China Sea*, 71-80, <http://jssm.umt.edu.my/wp->

<content/uploads/sites/51/2016/11/9-INOSw.pdf>.

- 6) Mohd Fadzil Mohd Akhir, Fredolin Tangang, Farshid Daryabor, Mohd Lokman Husain, Fangli Qiao, 2015, Evidence of Upwelling along Peninsular Malaysia during Southwest Monsoon. Open Journal of Marine Science, 5, 273-279. <http://dx.doi.org/10.4236/ojms.2015.53022>.

Q3: Early career professional's achievement- Better show the reference

A3: Inspired by the training courses, some trainees also finished papers for publication. The following are two latest examples.

- 1) Mamnun, Nabir; Bricheno, Lucy M.; Rashed-Un-Nabi, Md. 2020, Forcing ocean model with atmospheric model outputs to simulate storm surge in the Bangladesh coast. Tropical Cyclone Research and Review, <https://doi.org/10.1016/j.tcorr.2020.04.002>.
- 2) Kashem Mir, Ahmed Md Kawser, Qiao Fangli, Akhter M A E, Chowdhury K M Azam, 2019, The response of the upper ocean to tropical cyclone Viyaru over the Bay of Bengal. Acta Oceanologica Sinica, 38(1): 61-70, <https://link.springer.com/article/10.1007/s13131-019-1370-1>.

Q4: If possible, it is better to describe in details about “needs” and servicing to these, by showing the references of reports, papers, and conference presentations even in local languages of Thai and Malaysia.

A4: Trainees have applied the gained knowledge into serving their home countries and local people. Taking PMBC of Thailand as an example, each year the RTRC-ODC received about 3 trainees from PMBC, and what they have learned from the trainings were successfully applied in the protection of local marine ecosystem as well as in the searching and rescuing tasks of maritime accidents. Besides, long-term cooperation resulted in the first operational Ocean Forecasting System in Thailand at PMBC in 2015 (website: 110.49.56.166/thailand/) and the operational forecasting results have been published and shared through both the website (in English) and Mobile APP (in Thai, Malay and English languages), and more advanced training on how to use OFS was jointly organized by WESTPAC and PMBC.

Q5: whether an early career professional network was established? It is also a good indicator.

A5: A preliminary early career professional network was established through sharing advanced ocean scientific knowledge with all trainees by irregular emails from RTRC-ODC. To set up a formal network of early career professional is a good idea.

Q6: Perhaps starting with 3DVar would be better than directly starting with 4DVar, as 4DVar system will need more computer resources and will not be fit to many MS computing resources even in 2025.

A6: It is a very good suggestion.