南アフリカ共和国
南部アフリカにおける気候予測モデルをもとにした感染症流行の早期警戒システムの構築プロジェクト
中間レビュー報告書

2016 年 10 月

独立行政法人
国際協力機構（JICA）
人間開発部

人間
JR
16-079

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付属資料

略　語　表

略　語	正式名称	日本語
ACCESS	Applied Centre for Climate and Earth Systems Science	気候地球システム科学応用センター
AMED	Japan Agency for Medical Research and Development	国立研究開発法人　日本医療研究開発機構
ARC	Agricultural Research Council	農業研究評議会
C/P	Counterpart Personnel	カウンターパート
CSIR	Council for Scientific and Industrial Research	南アフリカ科学・工学研究評議会
DST	Department of Science and Technology	（南アフリカ）科学技術省
DOH	Department of Health	（南アフリカ）保健省
GIS	Geographical Information System	地理情報システム
GPS	Global Positioning System	全地球測位システム
iDEWS	（Climate Prediction-based）infectious Diseases Early Warning System	（気候予測に基づいた）感染性疾患流行早期警戒システム
IHR	International Health Regulation	国際保健規則
IRS	Indoor Residual Spraying	殺虫剤屋内残留噴霧
JAMSTEC	Japan Agency for Marine-Earth Science and Technology	国立研究開発法人　海洋研究開発機構
JCC	Joint Coordinating Committee	合同調整委員会
JICA	Japan International Cooperation Agency	独立行政法人　国際協力機構
JST	Japan Science and Technology Agency	科学技術振興機構
LAMP	Loop-mediated Isothermal Amplification	LAMP 法
LDOH	Department of Health-Limpopo	リンポポ州保健局
LDOH-Malaria	Department of Health-Limpopo, Malaria Control	リンポポ州保健局（マラリア予防対策センター）
MM	Minutes of Meeting	協議議事録
MOU	Memorandum of Understanding	了解覚書*
NDMC	National Disaster Management Centre	国家災害管理センター
NEKKEN	Nagasaki University Institute of Tropical Medicine	長崎大学熱帯医学研究所
NGO	Non-Governmental Organizations	非政府組織
NICD	National Institute for Communicable Diseases	国立伝染病研究所
ODA	Official Development Assistance	政府開発援助
OVIs	Objectively Verifiable Indicator (s)	（プロジェクト目標や成果達成度測定のための）指標

* 他の JICA 技術協力プロジェクトにおける討議議事録（Record of Discussions：R/D）に相当。

略　語	正式名称	日本語
PCM	Project Cycle Management	プロジェクト・サイクル・マネジメント
PDM	Project Design Matrix	プロジェクト・デザイン・マトリックス
SADC	Southern African Development Community	南部アフリカ開発共同体
SAMRC	South African Medical Research Council	南アフリカ医学研究評議会
SATREPS	Science and Technology Research Partnership for Sustainable Development	地球規模課題対応国際科学技術協力
SAWS	South African Weather Service	南アフリカ気象サービス
SOP	Standard Operating Procedure	標準操作手順書
TICAD	Tokyo International Conference on African Development	アフリカ開発会議（アフリカ開発における東京国際会議）
TMI	Tzaneen Malaria Institute	ザニンマラリア研究所
UCT	University of Cape Town	ケープタウン大学
UL	University of Limpopo	リンポポ大学
UP	University of Pretoria	プレトリア大学
UV	University of Venda	ヴェンダ大学
UWC	University of the Western Cape	西ケープ大学
WHO	World Health Organization	世界保健機関
WRF	Weather Research and Forecasting	領域気象モデル
ZAR	Zuid-Afrikaans Rand	南アフリカランド

中間評価調査結果要約表

１．案件の概要		
国名：南アフリカ共和国		案件名：南部アフリカにおける気候予測モデルをもとにした感染症流行の早期警戒システムの構築プロジェクト
分野：保健医療		援助形態：技術協力プロジェクト （地球規模課題国際科学技術協力）
所轄部署：人間開発部 保健第一グループ 保健第二チーム		協力金額：2 億 9,000 万円
協力期間	（R/D）： 2014 年 5 月 12 日～ 2019 年 5 月 11 日	先方関係機関：科学技術省（DST）、保健省（DOH）、気候地球システム科学応用センター（ACCESS）、南アフリカ医学研究評議会（SAMRC）、南アフリカ科学・工学研究評議会（CSIR）、国立伝染病研究所（NICD）、南アフリカ気象サービス（SAWS）、リンポポ州保健局（LDOH）、リンポポ州保健局（マラリア予防対策センター）（LDOH-Malaria）、ケープタウン大学（UCT）、リンポポ大学（UL）、プレトリア大学（UP）、ヴェンダ大学（UV）、西ケープ大学（UWC）
		日本側協力機関：長崎大学熱帯医学研究所（熱研）、国立研究開発法人 海洋研究開発機構（JAMSTEC）
		他の関連協力：該当なし。

１－１　協力の背景と概要

マラリアや下痢症、肺炎などの感染性疾患は、気候の変動、具体的にはラニーニャ現象などの大気海洋相互作用や気温・降雨量などの季節変動の影響を受ける可能性があることが示唆されている。南アフリカ共和国（以下、「南アフリカ」と記す）を含む南部アフリカ地域ではこのような感染性疾患の危険に常にさらされている。しかしながら、気候変動と感染性疾患の発生との関係が強く示唆されていながら、その具体的な相関関係が科学的に証明されることがなかったため、気候に基づく感染症流行予測を用いた対策は今日まで実現していない。

他方、地球規模課題対応国際科学技術協力（Science and Technology Research Partnership for Sustainable Development：SATREPS）の枠組みで実施された JICA 技術協力「気候変動予測とアフリカ南部における応用プロジェクト」（2010-2013）は、南アフリカと日本の研究機関の共同研究により、精度の高い気候変動予測システム（SINTEX-F）を開発した。「南部アフリカにおける気候予測モデルをもとにした感染症流行の早期警戒システムの構築プロジェクト」（以下、「本プロジェクト」と記す）は、先のプロジェクトで開発した気候変動予測システムの予測性能を更に高めるとともに、特にマラリア、下痢性疾患及び肺炎について気候変動に基づく感染性疾患流行早期警戒システム（infectious Diseases Early Warning System：iDEWS）の構築と運用性の検証を目的とし、SATREPS の枠組みで 2014 年 5 月に開始された。

今回実施の中間レビュー調査は、南アフリカ側関係機関と合同で本プロジェクトの目標達成度や成果等を分析するとともに、プロジェクトの残り期間の課題及び今後の方向性について確認し、合同中間レビュー報告書に取りまとめ、関係者間で合意することを目的として実施された。

１－２　協力内容

(1) プロジェクト目標

南部アフリカへの適用に向けた先駆けとして、感染症対策のための気候予測に基づいた早期警戒システムモデルが確立される。

(2) 成果

1) 特にマラリア、肺炎、下痢症について、気候に基づいた感染症流行予測モデルが開発される。

2) 気候予測に基づいた感染性疾患流行早期警戒システム（iDEWS）の運用指針がリンポポ州で策定される。

3) iDEWS の予測性能と運用性が実証される。

(3) 投入（評価時点）

1) 日本側

・専門家派遣：長期専門家 2 名（疫学・医用昆虫学、業務調整）（42 人/月）、短期専門家合計 14 名（13.8 人/月）

・機材供与：自動気象観測装置、顕微鏡や人工環境装置、マラリア診断装置などの研究機器、解析用パーソナルコンピュータ、解析用ソフトウェアなど

・ローカルコスト負担：約 1,203 万 5,000 円

・外国人研究員の招へい：合計 12 名（研究打合せ、シンポジウム参加・発表など）

・本邦研修：合計 3 名（統計学的解析手法など）

2) 南アフリカ側

・カウンターパート（Counterpart Personnel：C/P）配置：合計 46 名（ACCESS：1 名、SAMRC：12 名、CSIR：6 名、NICD：1 名、SAWS：6 名、LDOH：1 名、LDOH-Malaria：2 名、UCT：3 名、UL：6 名、UP：2 名、UV：4 名、UWC：2 名）

・施設及び資機材：CSIR 及び LDOH-Malaria 内プロジェクト事務所スペース、LDOH-Malaria 内実験スペース、南アフリカ国内の全プロジェクト参画機関の既存の機器、プロジェクトに関係する利用可能なデータ、情報及び検体、CSIR 内テレビ会議システムの使用

・ローカルコスト負担：リンポポ州でのフィールド調査経費、入院患者情報データベース化のための経費、南アフリカ側 C/P 国内旅費・交通費、プロジェクト活動に必要な消耗品、プロジェクト事務所水道光熱費、研究機器や試薬など本邦調達物品の輸入通関費など

２．評価調査団の概要

	担当分野	氏　名	所　属
調査者	団長・総括	金井　要	JICA 人間開発部 技術審議役
	協力企画	内山　咲弥	JICA 人間開発部 保健第一グループ 保健第二チーム 職員
	評価分析	井上　洋一	㈱日本開発サービス　調査部　主任研究員

	感染症対策研究	渡邉　治雄	AMED　国際事業部 医療分野国際科学技術共同研究開発推進事業 プログラムオフィサー 国際医療福祉大学大学院　教授
	計画・評価	石井　克美	AMED 国際事業部 国際連携研究課　主幹
調査期間	2016 年 9 月 19 日～2016 年 10 月 4 日		評価種類：中間レビュー

３．評価結果の概要

３－１　実績の確認

（1）成果 1

JAMSTEC は CSIR と協力しながら、海氷を考慮した高解像度化した新型の大気−海洋結合モデルを用いた短期気候変動予測システム（SINTEX-F2）の開発に成功し、南部アフリカの気候予測の精度が大幅に向上した。また、SINTEX-F2 による地球規模季節予測情報の局地的高解像度化（ダウンスケーリング：約 10km^2 程度）にも成功している。

他方、感染症流行予測モデル開発に関しては、マラリアに関してはおおむね順調であるが、肺炎及び下痢症については、病院データのデータベース化が当初計画より大幅に遅れていることから、流行予測モデル開発が開始できていない。しかしながら、プロジェクトは肺炎、下痢症ともに気象データ（気温及び降水量）と一定の相関関係があることを示唆する予備試験結果を得ており、中間レビュー以降のモデル開発研究を加速させ、2017 年 3 月頃をめどにすべての感染症流行予測モデルの開発を終了する予定である。

（2）成果 2

プロジェクトの前半は、成果 1 の下で iDEWS の基礎となる研究成果の創出に南アフリカ側、日本側とも注力してきた。プロジェクトの 2 年目頃からは iDEWS 準備委員会の設立に向けた準備を徐々に開始したが、LDOH で本プロジェクトの窓口となる人材の異動等により、中間レビュー時点では委員会設立に向けた最終的な準備を進めているところである。しかしながら、委員会の運用規約が作成されており、メンバーが確定でき次第、プロジェクトは iDEWS 準備委員会の下で運用指針の完成に向けて活動を加速する予定である。

（3）成果 3

現時点では具体的な iDEWS 開発に向けた活動はリンポポ州で開始されておらず、中間レビュー以降はより綿密なプロジェクト進捗管理の下でプロジェクト活動が加速される必要がある。

他方、指標の達成状況に示したとおり、隣国への iDEWS 適用も視野に入れた協力の可能性についてモザンビークの関係当局と協議が開始されている。また、国内の他州への iDEWS 適用を念頭に、プロジェクトは適用性検証のための他州の対象 3 疾患のデータの収集を MRC 主導で開始している。

（4）プロジェクト目標

本プロジェクトでは中間レビューまでに既に気候変動予測モデル開発、感染症流行予測モデル開発で合計 14 報の学術論文を発表しており、今後も多くの論文が発表されることが見込まれている。このことは、SATREPS として研究成果を創出する目的にかなうだけで

なく、間接的に両国の研究機関の研究能力の向上を示唆するものである。

プロジェクト期間前半は、主に「研究」活動を主体とした技術面の確立が活動の中心であったが、中間レビュー以降はリンポポ州内での iDEWS 運用指針の作成や予測性能・運用性の確認、他州や隣国への展開のための iDEWS パッケージ化など、研究成果の社会実装のための活動が中心となる。そのため、プロジェクト活動ではユーザーとなる LDOH 等南アフリカ側行政機関の強いリーダシップやオーナーシップが発揮されることが必要であり、同時に、6 カ月程度の遅れも認められることから、プロジェクト期間終了までにモデルの開発を 3 つの対象疾患すべてで達成するためには、厳格な進捗管理を行うことが求められる。

３－２　評価結果の要約

（1）妥当性

プロジェクトの妥当性はこれまで高く維持されている。

南アフリカを含む南部アフリカ諸国では感染症は依然として脅威であり、下痢症及び肺炎は南アフリカにおける 5 歳未満児死亡の上位 2 原因である。マラリアについては他の南部アフリカ諸国と比べるとよく制御されているが、モザンビークやジンバブエなどのマラリア浸淫国に国境を接している南アフリカ北東部、特に本プロジェクトの対象地域であるリンポポ州は依然としてマラリア感染リスクにさらされている。

南アフリカにおいて感染症対策の強化は「戦略計画 2015-2010」のなかで国家プログラム「一次医療サービス」に位置づけられ、感染症サーベイランスシステムの強化や国際保健規則（International Health Regulation : IHR）に沿った公衆衛生上の緊急事態への備えと対応能力強化を推進するとしている。また、南アフリカ政府は日本との科学技術協力の実施を重視しており、2014 年に南アフリカ科学技術省（Department of Science and Technology : DST）と在南アフリカ日本大使館が共同で発表した“South Africa-Japan Cooperation in Science and Technology”のなかでも南アフリカでの科学技術協力における JICA の重要性や SATREPS の役割などが明記されるとともに、本プロジェクトの内容も紹介されている。

他方、WHO は地球温暖化などの気候変動が感染症など人の健康に対する影響について対策の必要性を明確に示している。特に“WHO Global Programme on Climate Change & Health”（2016）のなかで気候変動と健康に関する科学的根拠を得ることの重要性を示している。したがって、本プロジェクトを通じて気候変動とマラリア、肺炎、下痢症との相関関係や気候変動に基づいた感染症流行予測モデルの開発、予測情報に基づく行政的な対応などに関する科学的分析は、このような国際的要求にもかなうものと考えられる。

（2）有効性

中間レビュー調査時点でのプロジェクトの有効性はおおむね高い。

気候変動予測モデルの開発については、SINTEX-F に南極の海氷の影響を考慮した改良を加えたことにより短期気候予測システムの高度化（SINTEX-F2 の開発）に成功した。SINTEX-F2 の開発は気候変動予測モデル開発の分野では、1 つのブレイクスルーといえる成果と考えられる。他方、感染症流行予測モデル開発については、マラリアでは順調に進捗しているが、肺炎や下痢症については紙ベースの病院入院情報の電子化とデータベース

化に遅れが生じており、中間レビュー時点でモデル開発に至っていない。しかしながら、プロジェクトはデータベース化が完了できれば、マラリアでのモデル開発のノウハウを活用して肺炎及び下痢症の流行予測モデル開発は比較的短期間で実施できることを見込んでいる。

中間レビュー以降は、少なくとも数カ月の予測期間で一定の予測精度を保証するような気候予測モデルと感染症流行予測モデルの連結のための研究が速やかに進められることが見込まれており、気候変動に基づいた感染症流行モデル開発にかかわる研究成果も学術誌に多く投稿されることが期待される。また、このように数多くの学術論文が国際誌に掲載されたことは、南アフリカ・日本国側双方の研究機関の機能強化や研究者の能力強化を間接的に証明していると考えられる。

(3) 効率性

予期しない外部要因により一部の研究活動に遅延が生じたため、中間レビュー時点でのプロジェクトの効率性は中程度である。

JICA 長期専門家の着任や南アフリカ側研究機関間了解覚書（Memorandum of Understanding：MOU）署名の遅れにより、プロジェクトの本格的な開始が遅れた。また、南アフリカ側の病院入院データのデータベース化のための予算が利用できるようになるのが 2016 年に入ってからとなったため、肺炎及び下痢症の流行予測モデル開発が中間レビュー時点で開始されておらず、おおむね半年～1 年程度の遅延と考えられる。また、iDEWS 準備委員会の設立も LDOH の主要なメンバーの異動等により中間レビュー時点でメンバーの最終化を行っている段階である。本プロジェクトも当初予定から約半年程度の遅延である。

中間レビュー以降は肺炎及び下痢症の流行モデル開発を加速させるとともに、気象予測モデルと感染症流行モデルの連結作業と予測期間及び予測精度の検証などの研究活動に並行して、いよいよリンポポ州においてこれら研究成果の社会実装（iDEWS 運用指針の作成や運用性の検証など）へとプロジェクト活動はシフトする。つまり、プロジェクトの実施者もこれまでの研究者に加え、リンポポ州の行政組織が主体的に活動することとなる。また、iDEWS は将来的には感染症サーベイランスや災害対策のメカニズムに組み入れられることを念頭においていることから、iDEWS 適用に向けたプロジェクト活動は南アフリカの法的・倫理的基準に沿って実施される必要がある。以上のことから、中間レビュー以降はより厳密な進捗管理、成果管理を行うことが強く求められる。

(4) インパクト

プロジェクトの実施によって、以下に示す正のインパクトが確認または期待されている。

SATREPS は研究成果の社会実装を強く意識した事業であり、プロジェクト目標にも「南部アフリカへの適用に向けた先駆けとして」と、感染症対策のための気候予測に基づいた早期警戒システムモデルが、プロジェクト期間終了後に南アフリカの自助努力によって他地域に適用されることを念頭においている。しかしながら、南アフリカの他州や隣国への適用を実現するには、プロジェクト期間内で iDEWS が行政システムの一部として機能す

ることを証明することが必要であるとともに、他地域への適用に向けたリソース分析（人材、コスト、時間など）と運用指針も含めたパッケージ化を完了することが必要である。中間レビュー時点ではプロジェクト全体としておよそ半年程度の遅延が認められており、厳密な進捗管理、成果創出管理の下で、プロジェクト活動を加速させる必要がある。

このほか、プロジェクトを通して確認、期待される正のインパクトとして、①南部アフリカの降水量の 10 年規模変動とマラリア患者数の関連、②データベース化された病院入院データの他の研究への活用、③ザニンマラリア研究所（Tzaneen Malaria Institute：TMI）の機能強化、が挙げられる。

（5）持続性

プロジェクトによって生み出された便益の自立発展、自己展開は中間レビュー時点においても一定程度見込まれる。

1） 政策的・制度的側面

南アフリカにおいて気候変動予測モデルや感染症流行予測モデル開発の技術力を高めながら、関連した研究成果に基づいた（根拠に基づく）感染症対策を行うことの政策的重要性はプロジェクト期間終了までのみならず、終了以降も継続することが強く見込まれるため、本プロジェクトの政策的持続性は中間レビュー時点においても一定程度期待できる。ただし、プロジェクトは iDEWS を行政システムの一部として運用することを念頭に、保健省（Department of Health：DOH）や国家災害管理センター（National Disaster Management Centre：NDMC）などの国家機関や法律顧問の助言を得ながら、慎重に制度化に向けた活動を実施することが求められる。

2） 財政的側面

上述のとおり iDEWS が感染症サーベイランスシステムや災害対策メカニズムの一部となれば、行政システムとして継続運営のための予算は担保されることが見込まれる。また、プロジェクトは iDEWS が将来的には南アフリカの他州や隣国で適用されることを念頭においていることから、プロジェクト活動の一部として運用コスト分析なども含めたパッケージ化を行うこととしていることから、継続運営のための予算計画に必要な情報はプロジェクトより提供される予定になっている。

3） 技術的側面

iDEWS に関する技術的持続性に関しては、州もしくは国の行政システムの一部としての運用を念頭においていることから、一定の持続性は担保されるはずである。しかしながら、そのためには、リンポポ州の行政組織等の機能や役割、医療環境も考慮に入れた実現可能性の高い運用規定を作成することが求められる。

３－３ 効果発現に貢献した要因

（1）計画内容に関すること

特になし。

（2）実施プロセスに関すること

本プロジェクトには実施機関だけで非常に多くの機関（合計 15 機関）が参加している

が、気候変動予測モデル開発にかかわる研究グループ、感染症流行予測モデル開発にかかわる研究グループともに、email や電話などを通して頻繁に連絡、協議等が行われている。このことは遠く離れた南アフリカと日本で共同研究が順調に実施され、上述したような研究成果が得られたことの一因と考えられる。

３－４　問題点及び問題を惹起した要因

(1) 計画内容に関すること

特になし。

(2) 実施プロセスに関すること

南アフリカ側のある実施機関は学生等に対する人材育成等に関しては大きなコミットメントがなされたが、諸事情により分担されていたある研究活動が主体的に実施されず、南アフリカに駐在する日本人研究者（JICA 専門家）が代わりに実施することによって、プロジェクトの進捗に対する負の影響を回避することができた。

本件は、同機関からプロジェクトに対して必要な投入が実施されなかったとの観点から、本プロジェクトの効率性を一定程度阻害したと考えられる。

３－５　結論

本プロジェクトは南アフリカ・日本国側双方の共同研究により科学的に重要な知見を生んでおり、その成果によってマラリア、下痢、肺炎の感染症対策に貢献することが期待される。

中間レビュー時点にて、妥当性と有効性は高く評価できる。妥当性は、南アフリカ・日本の科学技術政策及び感染症サーベイランスシステムの強化やIHRに沿った公衆衛生上の緊急事態への備えと対策能力強化といった南アフリカ保健省政策に合致している。有効性は、感染症予測モデルはマラリアで順調に開発されており、下痢症や肺炎においても関係者の協力の下、データが整理され気候との関係が解析されつつある。

効率性については中間レビュー時点では、外部要因により当初の予定より遅れがみられる活動が確認されたが、関係者の努力により研究の遅れは取り戻されつつあり、中程度であると考えられる。また、持続性については、プロジェクトによって生み出された便益の自立発展や広域展開は中間レビュー時点においても一定程度見込まれる。また、プロジェクトは学術的な成果に加え、特に南アフリカ・日本国側双方の若手研究者や学生の人材育成に大きな成果を生み出している。

なお、南アフリカと日本の研究機関の共同研究において、特に新規開発した短期気候変動予測システム（SINTEX-F2）を用いた研究から、以下のような重要な科学的知見を得ている。①南部アフリカ地域の降水量は季節変動や年々変動だけではなく、10 年規模でゆっくり変動しており、②この変動が南太平洋から南インド洋に東進する海面気圧と海面水温の 10 年規模変動と強く相関していることが明らかとなった。③これに関連し、リンポポ州でのマラリア患者数はモザンビーク南部及びジンバブエ南部の降水量と 3 カ月のラグで正の相関が認められた。④また気候と下痢症の関連性に関する初期的な解析から、iDEWS が下痢症に対して適用できる可能性を示した。

３－６　提言（当該プロジェクトに関する具体的な措置、提案、助言）

（1）iDEWS の開発について

・中間レビュー以降は研究成果の社会実装（気候予測に基づいた iDEWS を感染症対策実用モデルとしてリンポポ州内で確立）のための活動が中心となる。iDEWS はリンポポ州もしくは南アフリカの感染症サーベイランスシステムや災害対策メカニズムなど既存の行政システムの一部として運用されることが想定されることから、DOH や NDMC、法律顧問などの外部アドバイザーの協力を得て、LDOH、LDOH-Malaria、TMI 及び南アフリカ及び日本の研究機関は iDEWS 準備委員会として適切な協力関係を構築していくこと。

・南アフリカの他州や隣国への適用に向けて iDEWS のパッケージ化を行う際には、リンポポ州での試験運用に基づく iDEWS 運用のためのコスト（人、物、金、時間）についても分析を行うこと。

・警報発令基準の設定、予測情報に基づいた行政対応、システム運用の責任機関などは疾患ごとに異なる。また、疾患の原因となる病原体によって予防対策方法や治療などの対応が異なることも想定される。したがって、プロジェクトは iDEWS 運用指針作成に感染症サーベイランス・レスポンスに十分な知識・経験を有した専門家の追加投入も検討すること。

（2）肺炎と下痢症に関する iDEWS の開発について

・肺炎及び下痢症に関しては、病院入院患者データベース構築の遅れにより、プロジェクト工程に 6 カ月～1 年程度の遅れが認められることから、プロジェクト期間終了までにモデルの確立を 3 つの対象疾患すべてで達成するためには､厳格な進捗管理を行うこと。

・両疾患の発生率は気候との相関関係が認められている。また、南アフリカではマラリアに比して圧倒的に患者数や死亡者数が多いため､iDEWS を構築することについて一定の意義は認められる。しかしながら、疾患の種類や原因によって予防対策や治療法は異なるため、関係者間で両疾患をどのように定義するかについて共通理解を醸成すること。また、流行情報に基づいた具体的対応について、当該分野の専門家の協力も得ながら、エビデンスに基づき、リンポポ州の環境も考慮して慎重に iDEWS 準備委員会で協議を行うこと。

（3）持続性の確保

・「気象に基づいた感染症流行予測モデル」を構成する「気象予測モデル」「感染症流行予測モデル」はともに複数のモデルが開発されているが、それらモデルはプロジェクト期間終了までに南アフリカ側研究機関に引き渡され、プロジェクト期間終了後は南アフリカ側でモデルの微修正を含めて維持・管理が継続されることが必要となる。プロジェクト終了後も iDEWS が南アフリカで継続的に活用されるためには、その際にモデルの引き継ぎを念頭に統合や簡素化も含め、プロジェクト期間終了後のシステム維持に向けた具体的な検討を開始すること。

・共同で研究を実施していくことにより南アフリカ側研究者の人材育成を継続すること。また、中間レビュー以降は iDEWS 開発のためのプロジェクト活動を通じて、プロジェ

クトはリンポポ州における感染症サーベイランスシステムの強化のための人材育成も可能な限り実施すること。感染症サーベイランス情報の精度向上は、感染症流行予測モデルの予測精度向上にも貢献する。

(4) 他州や隣国への適用に向けた気候に基づく感染症流行予測モデルの適用可能性の検証

・本プロジェクトは南アフリカ内だけでなく、南部アフリカ諸国に対する iDEWS の適用も視野に入れている。既にリンポポ州と国境を接するモザンビークの関係当局と協議が開始されているが、プロジェクトは利用可能なデータ等を活用し、他国または国内の他州への適用可能性について検証すること。

３－７　教訓（当該プロジェクトから導き出された他の類似プロジェクトの発掘・形成、実施、運営管理に参考となる事柄）

(1) 本プロジェクトは SATREPS の枠組みで実施されており、プロジェクトで生み出された研究成果を社会実装することを強く意識している。実際に、プロジェクトの前半は iDEWS の基礎となる研究成果の創出に重点がおかれ、後半ではそれらを基に対象州での iDEWS 適用を行うことが予定されている。

具体的には、本プロジェクトは協力期間内に研究成果（iDEWS）の社会実装に向けた運用性や適用性の検証を実施することを計画しており、それに伴ってプロジェクトの実施も研究機関に加えて iDEWS のユーザーである行政機関（DOH や州保健局、NDMC など）が主体的にプロジェクトを実施する必要がある。しかしながら、本プロジェクトのデザインの段階（詳細計画策定調査時）に DOH や州保健局との緊密な協力関係の構築の必要性が事前評価表で指摘されていたが、中間レビュー調査時点ではそれらの機関を中心に構成される iDEWS 準備委員会の組織化に想定以上の時間と労力を要し、プロジェクトの遅延の一因となっている。

これまでの期間でプロジェクトから得られる教訓としては、プロジェクトの協力期間のなかで研究成果の社会実装に向けた具体的な準備活動をプロジェクト活動に含むことは SATREPS の原則に沿うものであるが、研究者ではない研究成果のユーザー（行政組織等）による社会実装に向けた研究成果の検証等をプロジェクト活動の一部とする場合は、プロジェクトは実際の検証作業が開始される前にしっかりとした協力関係、実施体制を構築できるよう、進捗管理を厳密に行うことが必要である。

Evaluation Summary

<table>
<tr><td colspan="3">1. Outline of the Project</td></tr>
<tr><td colspan="2">Country: the Republic of South Africa</td><td>Project Title: the Project for Establishment of an Early-Warning System for Infectious Diseases in Southern Africa incorporating Climate Predictions</td></tr>
<tr><td colspan="2">Issue/Sector: Healthcare and medical treatment</td><td>Cooperation Scheme: Technical Cooperation Project (Science and Technology Research Partnership for Sustainable Development: SATREPS)</td></tr>
<tr><td colspan="2">Division in charge: Health Team 2, Health Group 1, Human Development Department</td><td>Total Cost： Approx. 290 million JPY</td></tr>
<tr><td rowspan="3">Period of Cooperation</td><td rowspan="3">(R/D): 12/May2014 -11/May/2019</td><td>Partner Country’s Implementing Organization: the Department of Science and Technology (DST); the Department of Health (DOH); the Applied Centre for Climate and Earth Systems Science (ACCESS); the South African Medical Research Council (MRC); the Council for Scientific and Industrial Research (CSIR); the National Institute for Communicable Diseases (NICD); the South African Weather Service (SAWS); the Department of Health-Limpopo (DOHL); the Department of Health-Limpopo, Malaria Control (DOHL-Malaria); the University of Cape Town (UCT); the University of Limpopo (UL); the University of Pretoria (UP); the University of Venda (UV); and the University of the Western Cape (UWC)</td></tr>
<tr><td>Supporting Organization in Japan: the Nagasaki University Institute of Tropical Medicine; and the Japan Agency for Marine-Earth Science and Technology (JAMSTEC)</td></tr>
<tr><td>Other Related Projects: not applicable</td></tr>
<tr><td colspan="3">1-1. Background
It is suggested that the epidemic of certain infectious diseases such as malaria, diarrhea and pneumonia can be affected by climate variability, in particular, air-sea interactions such as La Niña effect, seasonal variability of ambient temperature and precipitation. Southern African countries including the Republic of South Africa (hereinafter referred to as “South Africa”) are being subject to danger of the said infectious diseases. As was just described, the relationship between climate variability and the incidence of infectious diseases is strongly suggested; nevertheless, its concrete correlative relationship has not been scientifically proven. For this reason, climate-based infectious disease epidemic prediction has not been used for practical measures for infectious diseases control to this date.
On the other hand, a climate variability prediction system with high prediction accuracy (SINTEX-F) was developed through the collaborative research of the South African and Japanese research institutes with the support of a former JICA’s technical cooperation entitled “the Project for Prediction of Climate Variations and its Application in the Southern African Region” (2010–2013), which was implemented under the scheme of the Science and Technology Research Partnership for Sustainable Development (hereinafter referred to as “SATREPS”). On the basis of the said project, “the Project for Establishment of an Early-Warning System for Infectious Diseases in Southern Africa incorporating Climate Predictions” (hereinafter referred to as “the Project”) is launched in May</td></tr>
</table>

2014 under the scheme of SATREPS, aiming to further improve the prediction skill of the SINTEX-F, followed by the establishment and subsequent operability verification of climate variability-based infectious disease early-warning systems (hereinafter referred to as "*iDEWS*"), especially for malaria, diarrheal diseases and pneumonia.

The Joint Mid-term Review will be conducted jointly with authorities concerned of the South African side to review performance and achievements of the Project, and to provide recommendations to offer solution against current challenges as well as a direction of the Project for the rest of the project period.

1-2. Project Overview

(1) Project Purpose

A climate-based early-warning system model for infectious diseases control is established as a precursor for further application across southern Africa.

(2) Outputs

1) Climate-based infectious disease epidemic prediction models are developed especially for malaria, pneumonia and diarrhea.
2) Operational guidelines of the climate prediction-based infectious diseases early warning system (iDEWS) are developed in the Limpopo Province.
3) Prediction performance and operability of the iDEWS are verified.

(3) Input (as of the Evaluation)

The Japanese Side

- Dispatch of JICA Experts：Long-term Experts: 2 persons (Epidemiology/medical entomology research and Project Coordinator, 42 M/M), Short-term Experts：a total of 14 persons (13.8 M/M)
- Provided Equipment： Automatic Weather Observation System, research / laboratory instrument and related equipment such as microscopies, artificial environment test system, personal computers for data processing and analyses, software for data analyses, etc.
- Local Cost：approx. JPY12,035,061 (≒ USD 103,795)
- Invitation of Researchers from Abroad: a total of 12 persons (research meetings, participation and presentation at the project open symposium, etc.)
- Training in Japan： a total of 3 persons (Theory and practice of statistical methods)

The South African Side

- Counterparts：a total of 27 persons (1 from ACCESS; 12 from MRC; 6 from CSIR; 1 from NICD; 6 from SAWS; 1 from DOHL; 2 from DOHL-Malaria; 3 from UCT; 6 from UL; 2 from UP; 4 from UV; and 2 from UWC)
- Facilities, Equipment and Materials: Project office spaces in CSIR and DOHL-Malaria; Laboratory space un DOHL-Malaria; Existing research instruments, equipment and/or devices in the South African counterpart organizations; Available data, information and/or specimens related to the Project; and Availability of teleconference system in CSIR
- Local Costs: Costs for field survey in the Limpopo province, the development of database for hospital inpatients information, domestic transportation of the South African counterpart personnel, utilities for the project office, consumables used for the project activities, custom clearance of the materials procured in Japan such as research instruments and reagents, etc.

2. Mid-term Review Team			
Members	Dr. Kaname KANAI	Leader	Executive Technical Advisor to the Director General, Human Development Department, JICA
	Ms. Saya UCHIYAMA	Cooperation Planning	Staff, Health Team 2, Health Group 1, Human Development Department, JICA
	Dr. Yoichi INOUE	Evaluation and Analysis	Senior Consultant, Consulting Division, Japan Development Service Co., Ltd.
	Prof. Dr. Haruo WATANABE	Infectious Diseases Control Research	Program Officer, International Collaborative Research Program, Department of International Affairs, AMED Professor, the Graduate School of the International University of Health and Welfare
	Mr. Katsumi ISHII	Planning and Evaluation	Deputy Manager, Division of International Collaboration, Department of International Affairs, AMED
Period of Evaluation	17/Sep/2016 - 6/Sep/2016		Study Type: Mid-term Review

3. Summary of Evaluation Results

3-1. Achievements

(1) Output 1

The JAMSTEC, with the support of the CSIR, had succeeded in developing a novel seasonal prediction system based on an ocean-atmosphere coupled general circulation model called SINTEX-F2 with higher resolution, which was developed on the basis of SINTEX-F by taking Antarctic sea ice into consideration. The SINTEX-F2 improved its prediction accuracy in southern Africa significantly. Moreover, The JAMSTEC had succeeded in downscaling of global seasonal forecasting into local-scale prediction covering as narrow as approx. 10km^2.

Meanwhile, concerning the development of infectious disease epidemic prediction models, that of malaria has been proceeding smoothly in general, whereas that for pneumonia and diarrhea has not been even commenced as of the time of the Mid-term Review, since the construction work of the database of hospital inpatient data was subject to significant delay. The Project, nevertheless, gained preliminary analysis results, which suggests a correlative relationship between the climate variability and the said two communicable diseases to a certain extent. Based on the said findings, the Project is supposed to accelerate their research activities for the development of infectious disease epidemic prediction models for all three target diseases until March 2017.

(2) Output 2

During 1st half of the project period, the Project has been putting efforts into the research-oriented activities by both South African and Japanese researchers for the establishment of basic technologies for the iDEWS. From the 2nd year of the project period, both South African and Japanese researchers have commenced preparations for the preparation committee of the iDEWS. However, due to the transfer of a focal person of the Limpopo province and other managerial issues, the Project is still at the finalization stage for the establishment of the iDEWS preparatory committee. Having said that, the Project has already drafted a terms of references (TOR) of the committee; thus, once the committee members are fixed, the Project, at the initiative of the iDEWS preparatory committee, is

supposed to accelerate project activities for the development of operational guidelines of iDEWS.

(3) Output 3

Practical work for the development of iDEWS has not been commenced in the Limpopo province as of the time of the Mid-term Review; thus, the remaining project activities should be accelerated under the strict progress management of the Project after the Mid-term Review.

Meanwhile, the Project started discussion with the authorities concerned of the Republic of Mozambique in light of future application of the iDEWS to neighboring countries. Besides, the Project, at the initiative of the MRC, started activities for the collection of retrospective incidence data of malaria, pneumonia and diarrhea in other provinces in South Africa for testing the applicability of the climate-based infectious diseases epidemic prediction models for the target 3 diseases.

(4) Project Purpose

The Project, even at the halfway point of the project period indeed, has already published a total of 14 research articles in international journals, and more research articles are anticipated to be published during the 2nd half and even after the project period. This is considered that the achievements of the Project meet the requirement of SATREPS (generation of research outcomes), and implies the enhancement of research capacity in both South African and Japanese research institutes indirectly.

The Project has mainly been working on the establishment of technologies on the basis of the "*research*" activities during 1st half of the project period, whereas, it is supposed that the Project will shift their activities from the research activities to practical application of research outcomes to the society; i.e. the establishment of the climate-based iDEWS as practical model(s) through the development of the operational guidelines, the verification of prediction performance and the packaging of the iDEWS for distribution it to other provinces and even neighboring countries. In order to realize that, it is considered that strong leadership and ownership of the Project should be exercised by the Limpopo governmental organizations such as the DOHL. The Project, simultaneously, is desired that stricter progress management should be done to complete the development of iDEWS for all 3 target diseases by the end of the project period, since the project activities already lag behind schedule by approx. 6 months as of the time of the Mid-term Review.

3-2. Summary of Evaluation Results

(1) Relevance

The relevance of the Project has been highly maintained hitherto.

In Southern African countries including South Africa, infectious diseases are still major threats and diarrhea and pneumonia are the top two causes ofuner-5 mortality in South Africa. Malaria is well controlled in comparison to other Southern African countries. However, the Northeast regions of South Africa sharing the borders with malaria endemic countries such as Mozambique and Zimbabwe including the Limpopo province, which is the target region of the Project, are especially exposed to malaria infection risks. Under such conditions, the national DOH positioned the reinforcement of infectious disease countermeasures as the "*primary medical service*" of the national program in "*Strategic Plan 2015-2020*". It promotes the strengthening of the infectious disease surveillance system and strengthening preparedness and core response capacities for public health emergencies in

line with the International Health Regulations (IHR). The Government of South Africa stresses the implementation of the science and technology cooperation with Japan. The "*South Africa-Japan Cooperation in Science and Technology*" that was jointly announced by the DST of South Africa and the Japanese Embassy in South Africa stipulates the importance of JICA in the science and technology cooperation in South Africa and the role of SATREP and also provides the introduction of the Project.

Meanwhile, WHO clarifies the necessity for the countermeasures for the impact of climate change such as global warming on the health of people. In particular, "*WHO Global Programme on Climate Change & Health*" (2016) indicates the importance of obtaining the scientific basis relating to climate change and health. Therefore, the development of infectious disease epidemic prediction models based on the correlation between climate change and malaria, pneumonia, and diarrhea and scientific analysis relating to the administrative handling based on the prediction information are also considered to meet such international demands.

(2) Effectiveness

The effectiveness of the Project is considered to be high in general at the time of the Mid-term Review.

It is notable that the Project succeeded in developing a novel seasonal prediction system based on an ocean-atmosphere coupled general circulation model called SINTEX-F2, which was developed on the basis of SINTEX-F by taking Antarctic sea ice into consideration and better resolution. The development of SINTEX-F2 is deemed to be a breakthrough in the field of the climate variability prediction modeling. The South African research institutes are also working on the development of climate variability prediction models with the direct or indirect support of the Japanese research institutes. On the other hand, concerning the development of infectious disease epidemic prediction models, that of malaria has been proceeding smoothly in general, whereas that for pneumonia and diarrhea has not been even commenced as of the time of the Mid-term Review, since the construction work of the database of hospital inpatient data was subject to significant delay. However, the Project estimated that the epidemic prediction modeling for pneumonia and diarrhea well be completed in a relatively short period of time using experience and know-how of that for malaria.

After the time of the Mid-term Review, the Project is supposed to move on to the research activities to link up the climate prediction models with infectious disease epidemic prediction models with securing sufficient prediction performance and lead time (a couple of months at least). Thus, it is anticipated that more research articles regarding climate-based infectious disease epidemic prediction modeling will be published hereafter. Looking at that from another perspective, a number of research articles published in peer-reviewed international journals might indirectly explain the enhancement of the capacity of research institutes as well as researchers in both South Africa and Japan.

(3) Efficiency

The efficiency of the Project is moderate since unexpected external factors caused delays in several research activities as of the time of the Mid-term Review.

Full-scale operation of the Project lagged behind schedule to some extent due to the delay in the arrival of JICA long-term expert in South Africa as well as the delay in the signing of the Memorandum of Understanding (MOU) among South African project member institutes. As has been described the budget allocated by the South African side for the construction of the database of

hospital inpatient information became available eventually in 2016; for this reason, epidemic prediction modeling for pneumonia and diarrhea has not been commenced as of the time of the Mid-term Review, and it is estimated that this activity is lagging behind schedule by approx. 6 - 12 months. Apart from this, the Project is still working on the establishment of the iDEWS preparatory committee by finalizing the members due to the transfer of a focal person in the Limpopo province, which also resulted in the delay by approx. 6 months.

The Project is required to accelerate their research activities for the development of epidemic prediction models for pneumonia and diarrhea. The Project is supposed to move on to the research activities for linking up of the climate prediction models to the infectious disease epidemic models, followed by the verification of prediction performance as well as its lead time. The Project, in parallel with those research activities, will shift their focus to the practical application of research outcomes to society in the Limpopo province (i.e., the development of iDEWS operational guidelines and subsequent verification of its operability). Accordingly, the administrative organizations in the Limpopo province such as the DOHL are supposed to take leading role for the activities for the said application work in tandem with the South African and the Japanese research institutes. Meanwhile, it is anticipated that the iDEWS will be operated as a part of infectious disease surveillance system and/or disaster management system in the Limpopo province and/or at national level; therefore, the Project is required to follow legal and ethical standards in South Africa for the project activities aiming at the application of the iDEWS for the said systems. For these reasons, it is strongly required for the Project to strengthen the management of the progress and the generation of outcomes further after the time of the Mid-term Review.

(4) Impact

The following positive impacts are confirmed and expected by the implementation of the Project.

SATREPS Project puts greater emphasis on the practical utilization of research outcome of projects to society; therefore, the Project clearly describes the expression of “as a precursor for further application across southern Africa”, and the climate-based iDEWS model(s) for better control of infectious diseases in southern Africa are expected to be applied by their self-help endeavor after the end of the project period. However, in order to realize the application of the iDEWS to other provinces in South Africa and even other countries, the Project is required to prove that the iDEWS is functioned properly as a part of administration system, and also, to complete packaging iDEWS operational guidelines, resource analyses (e.g. human resource, operational costs and timeframe) and other necessary elements for the application of iDEWS by the end of the project period. Further, the whole project activities seemed to lag behind schedule by approx. 6 months. For these reasons, the Project should accelerate the project activities after the time of the Mid-term Review under the strict management of progress and achievements.

Meanwhile, the positive impacts derived from the Project are as follows: 1) Relationship between the decadal change in the precipitation in southern Africa and the malaria incidence; and 2) Utilization of the database of hospital inpatients information for other researches; and 3) Functional enhancement of the Tzaneen Malaria Institute.

(5) Sustainability

A self-sustainability as well as a self-deployment of the benefits provided by the Project can be expected to some extent as of the time of the Mid-term Review.

Political and institutional aspects: The political importance of the implementation of the infectious disease countermeasures based on the results of the relevant research (based on the reason) while enhancing the technological capability of the development of climate change prediction models and infectious disease prediction models in South Africa is expected to be strongly maintained up to and also beyond the end of the project. The political sustainability of the Project is expected to some extent at the time of the Mid-term Review. However, the activities of the Project must be carried out carefully towards institutionalization of iDEWS while obtaining advice from the state organizations and legal advisers such as the DOH and National Disaster Management Center, keeping in mind that the iDEWS is to be operated as a part of the Administrative system.

Financial Aspect: Given that the iDEWS is included as a part of the infectious disease surveillance system or the disaster countermeasure mechanism, the budget for the continuous operation is expected to be secured as an Administrative system. Since future adaptation of the iDEWS in other provinces and neighboring countries of South Africa is considered in the Project and packaging including the operation cost analysis is conducted as a part of the project activities, the information required for the budget plan for continuous operation is expected to be provided by the Project.

Technical Aspect: the technical sustainability of iDEWS can be secured if it is operated as a part of administration system at provincial and/or national level. For the sake of that, the Project is required to develop operational guideline of iDEWS with high feasibility, which meet the function and responsibilities of administrative organizations as well as the environment of health services in the Limpopo province.

3-3. Factors that promoted the attainment of the Project

(1) Concerning the project design

No major promoting factor have been observed as far as the project plan is concerned.

(2) Concerning the implementation process of the Project

Many institutes including the implementation institutes (14 institutes in total) participated in the Project. Frequent communications and discussions were held via e-mail and telephone within both the research groups that are engaged in the development of climate change prediction models and the groups that are engaged in the development of infectious disease epidemic prediction models. These are the factors for achieving smooth implementation of joint research in remote mode between South Africa and Japan and for acquiring the research results as described above.

3-4. Factors that impeded the attainment of the Project

(1) Concerning the project design

No major obstacles have been observed as far as the project plan is concerned.

(2) Concerning the implementation process of the Project

A South African research institute could not do assigned project research fully due to various reason, whereas they provided great help for the capacity building geared to students in South Africa. However, the JICA expert stationed in South Africa strongly support the activity and owing to that, critical effect on the progress of the Project was avoided.

This can be recognized as a hindering factor since necessary input from the South African side has not been fully exercised.

3-5. Conclusions

As of the time of Mid-Term Review, the Project has produced many research outcomes which lead to the establishment of the iDEWS. The iDEWS is expected to contribute for the infectious disease control of malaria, diarrhea, and pneumonia.

The Project can be highly evaluated in terms of relevance and effectiveness. For the relevance, there are high consistencies with both South African and Japanese policies on the science and technology as well as the policy of national DOD to strengthen the infectious disease surveillance system and strengthening preparedness and core response capacities for public health emergencies in line with International Health Regulations (IHR). For the effectiveness of the Project, the development of prediction models for malaria incidence is on the process of the verification. Inpatient data has been registered into database through the efforts of the members and will be ready to analysis with climate factors.

The efficiency of the Project is moderate owing to the unexpected external factors, which caused delays in several research activities but those are managed through efforts of the project team as of the time of the Mid-term Review. The sustainability is expected to be high since the Project provides the sustainability as well as a border deployment. In addition to the scientific achievements, the Project has achieved significant human resource development, especially for young researchers and students in both South Africa and Japan.

The South Africa – Japan collaborative research has produced several important findings obtained through the newly developed SINTEX-F2 seasonal climates prediction system and analysis of real climates observation as follows: 1) decadal change in the rainfall (precipitation) in the area of southern Africa on top of the annual or seasonal change; 2) a strong correlative relationship between the said decadal change of rainfall and other decadal change in sea surface temperature as well as pressure that moves eastward from the South Atlantic Ocean to the South Indian Ocean; 3) in this regard, the Project points out that the possibility of positive correlation between the decadal climate change in southern Africa and the malaria incidence in the Limpopo province with 3-month time lag; and 4) preliminary analyses that climate drives diarrhea show potential successful application of iDEWS.

3-6. Recommendations

(1) Development of iDEWS

- After the time of the Mid-term Review, the Project will focus on the activities for the practical application of the research outcomes to society (i.e., the establishment of the climate-based iDEWS as a practical model in the Limpopo province). It is envisaged that the iDEWS is operated as a part of the administrative system such as infectious disease surveillance system and/or disaster management system in the Limpopo province and/or the national level; therefore, the Project should develop a proper collaborative relationship among iDEWS preparatory committee members such as the DOHL, the DOHL-Malaria, the TMI and South African and Japanese research institutes, with the support of the external advisors such as the national DOH, the NDMC and the legal advisor.
- The Project should perform resource analyses (human resource, necessary materials, costs and timeframe) for the operation of iDEWS based on the test operation in the Limpopo province when the Project develop an iDEWS package for the application to other provinces in South Africa and neighboring countries.

- The setting of alerting criteria, the administrative countermeasures based on the prediction information, and the responsible organization for the operation of iDEWS can be different in accordance with diseases. Likewise, it is envisaged that the way of prevention and control as well as treatment can vary in accordance with causative pathogens. Therefore, the Project should consider additional input of expert(s) with sufficient knowledge and experiences of infectious disease surveillance and response for the development of the operational guidelines of iDEWS.

(2) Development iDEWS for pneumonia and diarrhea

- Since the development of iDEWS for pneumonia and diarrhea is lagging behind schedule by approx. 6 to 12 months as of the time of the Mid-term Review due to the delay in developing database of hospital inpatient information, the Project should strengthen the progress management to complete the establishment of iDEWS for all 3 target diseases by the end of the project period.
- Pneumonia as well as diarrhea has a correlative relationship with climate. Besides, the incidence and casualty of pneumonia as well as diarrhea are overwhelmingly higher than that of malaria in South Africa. Therefore, the rationale of the development of iDEWS for pneumonia and diarrhea is secured. Having said that, since the prevention measures as well as treatment will be different in accordance with the type of diseases and/or causative pathogens, project members should reach a common understanding of the definition of "pneumonia" as well as "diarrhea". Further, the Project, at the initiative of the iDEWS preparatory committee, should carefully discuss evidence-based concrete countermeasures in accordance with the prediction information with the support of specialist(s) in consideration of the context in the Limpopo province.

(3) Securement of sustainability

- The Project developed several models for each "climate prediction model" as well as "infectious disease epidemic prediction model" for linking them up to develop a "climate-based infectious disease epidemic prediction model". Some of the said models are supposed to be handed over to the South African research institutes; thereafter, maintained and even fine-tuned by themselves. In order for the iDEWS to be utilized continuously in South Africa, the Project should start discussions among relevant organizations on the maintenance of iDEWS; simplification or unification of the models can be one option.
- The Project should continue the capacity building of South African researchers through the collaborative research. In parallel, the Project is expected to raise capacity of project members in the Limpopo province for the reinforcement of infectious disease surveillance system through the project activities for the development of iDEWS after the time of the Mid-term Review. The accuracy improvement of the information from the infectious disease surveillance will also contribute to the improvement of the performance of infectious disease epidemic prediction models.

(4) Verification of applicability of the climate-based infectious disease epidemic prediction models in light of the application to other provinces and neighboring countries

- The Project intends to apply the iDEWS not only to other provinces in South Africa but also southern African countries in future. The Project has already commenced discussions with the

authorities concerned in Mozambique, sharing the border with the Limpopo province; however, the Project should verify the applicability of iDEWS to other provinces and/or neighboring countries using currently-available data.

3-7. Lessons Learnt

The Project is implemented under the framework of "SATREPS"; as a matter of course, is aiming to apply research outcomes to social systems. In practice, the Project place a priority on the generation of research findings and outcomes which will be bases of following activities during the 1st half of the project period; subsequently, will shift themselves to activities for applying the research outcomes to the social system in the target province of the Project during the 2nd half of the project period.

In particular, the Project is planning to perform the verification of operability and applicability of iDEWS (a major outcome of the research of the Project) for the application of it to the social systems within the project period; accordingly, administrative organs of South Africa (i.e., the national DOH, the DOHL, the NDMC, etc.), in addition to the project research institutes, are anticipated to take leading role for the project activities as envisaged users f iDEWS, especially for the 2nd half of the project period. However, it took a longer-than-expected time for the Project to organize an iDEWS preparatory committee comprised of the said research and administrative institutes, resulted in the delay of the Project to some extent as of the time of the Mid-term Review, though the need of the establishment of cooperation cooperative relationship with the administrative organs in South Africa was pointed out in the ex-ante evaluation report at the time of the designing stage of the Project (the detailed planning survey).

A lesson learnt form the 1st half of the project period is as follows: though the implementation of preparatory activities for the practical application of research outcomes to social systems in the project period is considered to meet the principle of the SATREPS, the Project should do stricter progress management than usual for the establishment of a robust collaboration and/or implementation system of the Project in advance of the verification of research outcomes, in case that not project research institutes but rather end-users of the research outcomes such as administrative organs are supposed to play a leading role for it.

第１章　中間レビューの概要

１－１　調査団派遣の経緯

マラリアや下痢症、肺炎などの感染性疾患は、気候の変動、具体的にはラニーニャ現象などの大気海洋相互作用や気温・降雨量などの季節変動の影響を受ける可能性があることが示唆されている。南アフリカ共和国（以下、「南アフリカ」と記す）を含む南部アフリカ地域ではこのような感染性疾患の危険に常にさらされている。しかしながら、気候変動と感染性疾患の発生との関係が強く示唆されていながら、その具体的な相関関係が科学的に証明されることがなかったため、気候に基づく感染症流行予測を用いた対策は今日まで実現していない。

他方、地球規模課題対応国際科学技術協力（Science and Technology Research Partnership for Sustainable Development：SATREPS）の枠組みで実施された JICA 技術協力「気候変動予測とアフリカ南部における応用プロジェクト」（2010-2013）は、南アフリカと日本の研究機関の共同研究により、精度の高い気候変動予測システム（SINTEX-F）を開発した。「南部アフリカにおける気候予測モデルをもとにした感染症流行の早期警戒システムの構築プロジェクト」（以下、「本プロジェクト」と記す）は、先のプロジェクトで開発した気候変動予測システムの予測性能を更に高めるとともに、特にマラリア、下痢性疾患及び肺炎について気候変動に基づく感染性疾患流行早期警戒システム（infectious Diseases Early Warning System：iDEWS）の構築と運用性の検証を目的とし、SATREPS の枠組みで 2014 年 5 月に開始された。

今回実施の中間レビュー調査では、南アフリカ側関係機関と合同で本プロジェクトの目標達成度や成果等を分析するとともに、プロジェクトの残り期間の課題及び今後の方向性について確認し、合同中間レビュー報告書に取りまとめ、関係者間で合意することを目的とする。

１－２　中間レビューの目的

中間レビューの目的は以下に示すとおりである。

(1) プロジェクト・デザイン・マトリックス（Project Design Matrix：PDM）version 1（付属資料の別添 1）に基づいて進捗をレビューし、評価 5 項目（「妥当性」「有効性」「効率性」「インパクト」及び「持続性」）の評価基準に従って中間時点でのプロジェクトの達成度を評価する。

(2) プロジェクトの成果及び目標に対する促進要因及び阻害要因を検討する。

(3) 上記の分析結果に基づいて南アフリカ側と共同で残りのプロジェクト期間での活動方針について協議する。

(4) 今後のプロジェクト目標及び将来のスーパーゴールの達成に向けた提言を行うとともに、必要に応じて PDM の見直しを行う。

(5) 合同中間レビュー報告書に調査結果を取りまとめる。

１－３　合同レビュー調査団のメンバー

中間レビューは、JICA 側 3 名及び南アフリカ側 3 名の評価委員が合同で実施した。合同中間レビューチーム（以下、「レビューチーム」と記す）の構成は以下のとおりである。

なお、南アフリカにおける現地調査には、SATREPS の枠組みのなかで日本国内での研究を支援

している国立研究開発法人日本医療研究開発機構（以下、「AMED」と記す）[1]は JICA の実施する終了時評価調査と同時に 2 名の調査団を南アフリカにおける現地調査に派遣し、独自の評価調査を行うとともに、専門的見地から研究活動に対する技術的な助言を行った。

<日本側>

担当分野	氏　名	所　属	現地派遣期間
団長・総括	金井　要	JICA 人間開発部 技術審議役	2016 年 9 月 24 日～ 2016 年 10 月 4 日
協力企画	内山　咲弥	JICA 人間開発部 保健第一グループ 保健第二チーム 職員	2016 年 9 月 30 日～ 2016 年 10 月 5 日
評価分析	井上　洋一	㈱日本開発サービス　調査部　主任研究員	2016 年 9 月 18 日～ 2016 年 10 月 5 日

<南アフリカ側>

氏　名	役職及び所属
Dr. Isayvani NAICKER	Chief Director, International Relations, the Department of Science and Technology
Mr. Ben DURHAM	Chief Director, Bio-Innovation, the Department of Science and Technology
Ms. Manti MAIFADI	Deputy Director, Office of the Chief Director, the Department of Health

＜AMED 団員＞

担当分野	氏　名	所　属	全体調査期間
感染症対策研究	渡邉　治雄	AMED　国際事業部 医療分野国際科学技術共同研究開発推進事業 プログラムオフィサー 国際医療福祉大学大学院　教授	2016 年 9 月 28 日～ 2016 年 10 月 4 日
計画・評価	石井　克美	AMED 国際事業部　国際連携研究課　主幹	2016 年 9 月 28 日～ 2016 年 10 月 4 日

現地調査は 2016 年 9 月 19 日から 2016 年 10 月 4 日に実施し、サイト視察、インタビュー、プロジェクト報告書等の関連文書レビューを実施した（付属資料の別添 2.）。

１－４　プロジェクトの枠組み

プロジェクトの枠組みを以下に示す。

（1）プロジェクト期間：2014 年 5 月 12 日から 2019 年 5 月 11 日まで 5 年間

（2）プロジェクト管理：本プロジェクトの管理体制は以下のとおりである。

ープロジェクト・ダイレクター：科学技術省（Department of Science and Technology : DST）
バイオテクノロジー部門チーフ・ダイレクター

[1] SATREPS 感染症分野プロジェクトの所掌事務及び権限は、2015 年 4 月 1 日より AMED に移管された。

－プロジェクト・共同ダイレクター：保健省（Department of Health：DOH）伝染性疾患部門チーフ・ダイレクター[2]
－プロジェクト・マネジャー：気候地球システム科学応用センター（Applied Centre for Climate and Earth Systems Science：ACCESS）センター長
－チーフ・アドバイザー：長崎大学熱帯医学研究所（以下、「熱研」と記す）病害動物学分野教授

（3）プロジェクト実施機関：南アフリカ側及び日本側研究機関を示す。

1） 南アフリカ側

ACCESS、南アフリカ医学研究評議会（South African Medical Research Council：SAMRC）、南アフリカ科学・工学研究評議会（Council for Scientific and Industrial Research：CSIR）、国立伝染病研究所（National Institute for Communicable Diseases：NICD）[3]、南アフリカ気象サービス（South African Weather Service：SAWS）[4]、リンポポ州保健局（Department of Health-Limpopo：LDOH）、リンポポ州保健局（マラリア予防対策センター）（Department of Health-Limpopo, Malaria Control：LDOH-Malaria）、ケープタウン大学（University of Cape Town：UCT）、リンポポ大学（University of Limpopo：UL）、プレトリア大学（University of Pretoria：UP）[5]、ヴェンダ大学（University of Venda：UV）[6]、西ケープ大学（University of the Western Cape：UWC）

2） 日本側

熱研及び国立研究開発法人 海洋研究開発機構（以下、「JAMSTEC」と記す）

（4）裨益対象者：本プロジェクトの直接的、間接的な裨益対象者は、それぞれ南アフリカ側研究機関の研究者（46 名）、リンポポ州の住民（約 540 万人）である。

（5）プロジェクトの要約

最新の PDM version 1〔2014 年 8 月 6 日、第 1 回合同調整委員会（以下、「JCC」と記す）で承認〕に示されるプロジェクトの要約（プロジェクト目標、成果、活動）を以下に示す。

指標、入手手段、双方のプロジェクトへの投入、前提条件、外部条件等のその他の項目は、付属資料の別添 1.として添付された「PDM version 1」を参照のこと。

プロジェクト目標	南部アフリカへの適用に向けた先駆けとして、感染症対策のための気候予測に基づいた早期警戒システムモデルが確立される。
成果	成果 1 特にマラリア、肺炎、下痢症について、気候に基づいた感染症流行予測モデルが開発される。 成果 2

[2] 郡保健サービス局チーフ・ダイレクターから交代した。これに従って、2015 年 11 月 10 に科学技術省と JICA の間で了解覚書（以下、「MOU」と記す）（2014 年 5 月 12 日付）を修正するための協議議事録（以下、「MM」と記す）を取り交わした。
[3] 2015 年 10 月に開催された第 2 回 JCC で南アフリカ側のメンバーとして承認された。
[4] 2015 年 10 月に開催された第 2 回 JCC で南アフリカ側のメンバーとして承認された。
[5] 2014 年 8 月に開催された第 1 回 JCC で外部協力機関から南アフリカ側のメンバーとして承認された。
[6] 2014 年 8 月に開催された第 1 回 JCC で南アフリカ側のメンバーとして承認された。

	気候予測に基づいた感染性疾患流行早期警戒システム（iDEWS）の運用指針がリンポポ州で策定される。 成果 3 iDEWS の予測性能と運用性が実証される。
活動	活動 1 1-1. 感染症及び気候変動に関する前向き及び後ろ向きデータ/情報取得システムの構築 1-1-1. 現地の保健情報システムや医療施設の履歴情報等から得られるマラリア、肺炎及び下痢症のデータ/情報をデータベース化する。 1-1-2. データベースの過去のデータを用いて各疾患の危険度分布図を作成し、調査対象サイトを決定する。 1-1-3. 調査対象サイト内のコミュニティで各疾患の罹患率及び有病率（診断されていないものを含む）、感染症流行に影響のある住民行動（受療行動など）、衛生環境（水質、大気汚染、マラリア蚊の殺虫剤抵抗性など）の実態を調査し、データベースに組み入れる。 1-1-4. 南アフリカ気象サービス（SAWS）や農業研究評議会（Agricultural Research Council：ARC）などの ACCESS パートナー機関より、気候性及び非気候性補助的環境データ（地理情報等）を入手する。 1-1-5. 公共建物に基本的気象観測ステーションを設置し、基礎的調査対象サイト内の局地的気象データを測定する。 1-2. 対象疾患の罹患率/有病率、気候変動（気温、湿度、降雨量など）の関係性の解明 1-2-1. 対象疾患の罹患率/有病率と気候変動の関連性を時系列分析により調査する。 1-2-2. マラリア媒介蚊と気候変動、そして、マラリア罹患率/有病率との関係を調査する。 1-2-3. リンポポ州の局地気候変動と、エルニーニョ南方振動（ENSO）やインド洋ダイポールモード（IOD）、亜熱帯ダイポールモード（SDM）などの地球規模の気候変動現象との関連性を分析する。 1-3. リンポポ州の感染症流行状況を反映したマラリア、肺炎、下痢症の感染症数理もしくは、統計モデルの開発 1-3-1. マラリアやコレラなどの既存の感染症モデル（特に気候に関連した）をレビューする。 1-3-2. マラリア、肺炎、下痢症の基本的数理モデル及び統計モデルを改良または新規作成する。 1-3-3. データベースで得られた感染症の後ろ向き及び前向きデータ/情報を用いてモデルの予測性能を検証し、モデルを調整する。 1-4. 大気–海洋結合モデルを用いた短期気候変動予測システム（SINTEX-F）の高度化（予測精度の向上、予測情報の局地的な高解像度化、予測リード期間の長期化等） 1-4-1. 空間高解像度化、物理スキーム改善、データ同化による初期化精度を向上させた新型の SINTEX-F を開発する。 1-4-2. 既存の SINTEX-F や南アフリカの気候モデル等の相互比較を通

して、短期気候変動予測モデルのバイアスを低下させる。

1-4-3. SINTEX-F の地球規模季節予測情報を、力学モデル（WRF）や統計手法を用いて局地的に高解像度化し（ダウンスケーリング）、その予測性能向上や予測期間の長期化を行う。

1-4-4. 活動 1-4-3 と相互作用的に、対象地域の気候観測データ（活動 1-1 より）との相互比較を通して WRF モデルを高精度化する。

1-5. 気候に基づいたマラリア、肺炎及び下痢症の感染症流行予測モデルの開発

1-5-1. 活動 1-2 の対象疾患の罹患率/有病率、気候変動、ベクター間の関係性解析結果を踏まえ、感染症数理・統計モデルと改良気候変動予測システムを連結させて、気候に基づいた感染症流行予測モデルを作成する。

1-5-2. データベースで得られた過去数十年の感染症流行やアウトブレイクデータ/情報を用いてモデルの予測性能を検証し、モデルを調整する。

活動 2

2-1. 流行予測を担当する組織や流行/警戒情報発出を担当する組織、情報に基づいて対策を行う組織などによるリンポポ州 iDEWS 導入準備委員会を立ち上げる。

2-2. アウトブレイク警戒情報発令の基準を設定する。

2-3. リンポポ州内の感染症流行/警戒情報伝達方法を設定する。

2-4. 定期情報伝達方法、アウトブレイク警戒情報発令と対策行動、情報伝達フォーマット、運用組織等を含む iDEWS 運用指針を作成する。

活動 3

3-1. リンポポ州で iDEWS を試験運用し、iDEWS の予測性能及び運用性を評価する。

3-2. リンポポ州において、感染症アウトブレイク警戒情報発令と対策行動に係る机上訓練を実施する。

3-3. iDEWS がリンポポ州の感染症対策に及ぼす影響を分析するための持続性のあるモニタリング評価システムを作成する。

3-4. 利用可能な他州もしくは隣国の感染症流行データ、気候性及び非気候性環境データを用いて、iDEWS の適用性を検証する。

3-5. 他州や隣国への iDEWS の展開に向けて、南アフリカや隣国の気候変動や感染症対策を担当する行政官、研究者等の関係者を対象としたワークショップを開催する。

3-6. 南アフリカの気候変動や感染症対策を担当する行政官、研究者等の関係者と他州への iDEWS 展開に向けた協議を開始する。

第２章　中間レビューの方法

２－１　SATREPS におけるプロジェクトレビューの枠組みについて

SATREPS は JICA による現地での技術協力プロジェクト実施協力と AMED による日本国内での技術的・財政的研究支援が連携して推進されることから、評価活動実施の効率性もかんがみ、現地調査は JICA と AMED が連携、協力して実施される。

JICA はプロジェクト運営の一環として、政府関係者・研究代表者を含めた先方協力機関等と共同で、ODA 事業として相手国における人材育成、能力強化及び開発課題に対する貢献の観点から評価（レビュー）を実施する。また、AMED は地球規模課題の解決に資する研究成果、科学技術水準の向上の観点から日本国内及び相手国を含めた国際共同研究全体の評価を行う。

２－２　レビュー手法

中間レビューは「JICA 事業評価ガイドライン第 2 版」（2014 年 5 月）及び「JICA 事業評価ハンドブック（Ver.1)」（2015 年 8 月）に沿って実施された。実績・実施プロセスの確認と 5 項目評価を行うための具体的な方法を検討するため、評価設問、必要な情報・データ、情報源、データ収集方法について一覧表で示した「評価グリッド」（付属資料の別添 3.）を作成した。

レビュー・チームのメンバーは評価グリッドに基づき、カウンターパート（Counterpart Personnel：C/P）研究者や各関係機関、JICA 専門家に対して質問票やインタビューを実施し、プロジェクトのレビューを実施した（主要面談者は付属資料の別添 4.を参照)。

PCM の常法に則り、最新の PDM version 1 に基づいて指標の達成度を含めたプロジェクト実績を確認し、評価 5 項目での評価分析を行った。合同レビュー・チームは、評価結果を合同レビュー報告書に取りまとめた。

２－３　評価 5 項目

本中間レビューに用いた評価 5 項目の概説を以下に示す。

評価 5 項目	概　説
妥当性	プロジェクトの目標（PDM のプロジェクト目標、上位目標）が、受益者のニーズと合致しているか、援助国側の政策と日本の援助政策との整合性はあるかといった、「援助プロジェクトの正当性」を検討する。中間レビューでの妥当性評価は、現状・実績に基づいて検証作業を行う。
有効性	PDM の「プロジェクトの成果」の達成度合いと、それが「プロジェクト目標」の達成にどの程度結びついたかを検討する。中間レビューでの有効性評価は、現状・実績に基づいて検証作業を行う。
効率性	プロジェクトの「投入」から生み出される「成果」の程度を把握する。各投入のタイミング、量、質の適切度を検討する。中間レビューでの効率性評価は、現状・実績に基づいて検証作業を行う。
インパクト	プロジェクトが実施されたことにより生じる直接・間接的な正負の影響を検討する。中間レビューでのインパクト評価は、評価の必要性・可能性に応じて検証作業を行う。

持続性	援助が終了した後も、プロジェクト実施による便益が持続されるかどうか、自立発展に必要な要素を見極めつつ、プロジェクト終了後の自立発展の見通しを検討する。中間レビューでの自立発展性評価は、予測・見込みに基づいて検証作業を行う。

第３章　プロジェクトの実績と実施プロセス

３－１　投入

（1）日本側投入実績

以下に、2016 年 6 月末時点のプロジェクトに対する日本側からの投入を示す（詳細は付属資料の別添 5.を参照）。

構　成	投　入
日本人専門家の派遣	長期専門家：合計 2 名（疫学・医用昆虫学、業務調整）、42 人/月 短期専門家：合計 14 名、13.8 人/月（延べ 415 日間）
資機材の提供	内容：自動気象観測装置、顕微鏡や人工環境装置、マラリア診断装置などの研究機器、解析用パーソナルコンピュータ、解析用ソフトウェアなど（合計 3,373 万 933 円）
外国人研究員の招へい	合計人数：12 名 協議内容：南部アフリカ地域気候変動予測に関する研究打合せ（2 名、合計 18 日間）及びプロジェクト公開シンポジウム参加・発表と研究打合せ（10 名、合計 80 日間）
本邦研修	合計人数：3 名 研修内容： －地理情報システム（Geographical Information System：GIS）を用いた感染症危険分布図作成のための統計学的解析手法の理論と実践（2 名、熱研、22 日間） －感染症の発生件数と–気象データ間の相関解析に関する統計学的解析手法の理論と実践（1 名、JAMSTEC、21 日間)）
現地活動費	在外事業強化費：1,203 万 5,061 円 －2014 年度：389 万 9,227 円 －2015 年度：593 万 234 円 －2016 年度：220 万 5,600 円（見込額）

（2）南アフリカ側投入実績

以下に、2016 年 6 月末時点のプロジェクトに対する南アフリカ側からの投入を示す（詳細は付属資料の別添 5.を参照）。

構　成	投　入
C/P 配置	合計 46 名 1. 気候地球システム科学応用センター（ACCESS）：1 名 2. 南アフリカ医学研究評議会（SAMRC）：12 名 3. 南アフリカ科学・工学研究評議会（CSIR）：6 名 4. 国立伝染病研究所　（NICD）：1 名 5. 南アフリカ気象サービス（SAWS）：6 名 6. リンポポ州保健局：1 名 7. リンポポ州保健局（マラリア予防対策センター）（LDOH-Malaria）：2 名

	8. ケープタウン大学（UCT）: 3 名 9. リンポポ大学（UL）: 6 名 10. プレトリア大学（UP）: 2 名 11. ヴェンダ大学（UV）: 4 名 12. 西ケープ大学（UWC）: 2 名
施設及び資機材	1. CSIR 及び LDOH-Malaria 内プロジェクト事務所スペース 2. LDOH-Malaria 内実験スペース 3. 南アフリカ国内の全プロジェクト参画機関の既存の機器 4. プロジェクトに関係する利用可能なデータ、情報及び検体 5. CSIR 内テレビ会議システムの使用
現地活動費	リンポポ州でのフィールド調査経費、入院患者情報データベース化のための経費、南アフリカ側 C/P 国内旅費・交通費、プロジェクト活動に必要な消耗品、プロジェクト事務所水道光熱費、研究機器や試薬など本邦調達物品の輸入通関費など

３－２　プロジェクトの実績

（1）プロジェクト活動の実績

成果に係るプロジェクト活動実績を以下に示す。

成果 1 特にマラリア、肺炎、下痢症について、気候に基づいた感染症流行予測モデルが開発される。	
活　動	達成事項
1-1. 感染症及び気候変動に関する前向き及び後ろ向きデータ/情報取得システムの構築	
1-1-1. 現地の保健情報システムや医療施設の履歴情報等から得られるマラリア、肺炎及び下痢症のデータ/情報をデータベース化する。	・LDOH-Malaria と熱研主導で、迅速診断検査キットを用いた診断が行われた 1998 年以降のリンポポ州のマラリア患者発生データを収集し、汎用ソフトを用いてデータベース化している。2016 年 3 月時点で、約 8 万件が登録されている。データは今後も適宜追加されていく見込みである。 ・下痢症及び肺炎に関するデータ収集について －SAMRC と ACCESS 主導でグレーター・ギアニ地区のケンサニ病院の全入院患者情報約 28,000 件（2002～2016 年）のデータベースへの登録を実施中であり、データの品質向上作業（データ・クレンジング等）を実施予定である。データベース化は 2016 年 10 月頃には終了できる見込みである。研究にはデータベースから肺炎及び下痢症のデータを抽出して使用するが、現時点でそれらの疾患の件数は確認できない。 －また、ファラボルワ地区の病院のデータもデータベースに追加している。 －ACCESS は独自に保険会社から下痢症及び肺炎の病名での保険請求情報を 6 万～8 万件入手している。また、病院を受診しない程度の軽症例を反映するデータとして、止瀉薬（一般薬のロペラミド）販売量のデータも入手した。 ・マラリアに関するデータベース化は順調に進捗しているが、下痢症と肺炎情報のデータベース化は、南アフリカ側活動費が利

	用可能となった時期が想定より遅れたことや、膨大な紙ベースの情報の電子化作業に時間を要していることなどにより、予定よりおおむね 6 カ月～1 年程度の遅れが生じている。
1-1-2. データベースの過去のデータを用いて各疾患の危険度分布図を作成し、調査対象サイトを決定する。	・データベースの情報を用いて、LDOH-Malaria と熱研はマラリア感染危険度分布図を作成した。プロジェクトは分布図に基づき、集中調査対象地域にグレーター・ギアニ地区を選定した。 ・下痢症及び肺炎については、データベースが完成次第、SAMRC と熱研が主導で危険度分布図を作成する予定である。 ・ただし、危険度分布に大きな偏りがなければ、活動の効率性を考慮し、グレーター・ギアニ地区を対象地域とし、必要な調査を行うこととしている。
1-1-3. 調査対象サイト内のコミュニティで各疾患の罹患率及び有病率（診断されていないものを含む）、感染症流行に影響のある住民行動（受療行動など）、衛生環境（水質、大気汚染、マラリア蚊の殺虫剤抵抗性など）の実態を調査し、データベースに組み入れる。	・LDOH-Malaria、SAMRC 及び熱研は、2015～2016 年シーズンよりグレーター・ギアニ地区のコミュニティにおいて、ランプ法によるマラリア迅速診断キットを用いた無症候性マラリア感染状況の調査を約 500 世帯のコミュニティ住民に対して開始した。 ・また、同地区での殺虫剤屋内残留噴霧（Indoor Residual Spraying : IRS）実施状況に関する情報を調査した。 ・マラリア媒介蚊（ハマダラカ）の捕獲装置を 2015～2016 年シーズンに設置したが、蚊の密度が少ないため実験を行うだけの蚊を採取できず、殺虫剤抵抗性等の研究は実施できていない。現時点までは、過去の LDOH-Malaria にある過去のデータや他のグループの研究成果のレビューを行っている。なお、抵抗性に関する情報は感染症流行モデル開発のためではなく、むしろ iDEWS の下で予防対策を行うための情報として活用される見込みである。 ・他方、SAMRC はコミュニティにおいて、2015～2016 年シーズンに感染症流行に影響のある住民行動や、特に肺炎や下痢症の発生に影響する衛生環境、大気汚染などの状況の調査を実施した。2016 年 10 月に 2 回目の調査を実施予定である。
1-1-4. 南アフリカ気象サービス（SAWS）や農業研究評議会（ARC）などの ACCESS パートナー機関より、気候性及び非気候性補助的環境データ（地理情報等）を入手する。	・熱研、JAMSTEC 及び UL は、衛星観測による気象性データ、及び地理情報などの非気象性補助的環境データを協力機関等から入手し、既存の大気–海洋結合モデルを用いた短期気候変動予測モデル（SINTEX-F）の高度化（SINTEX-F2 の開発）や感染症危険度分布図作成に活用した。 ・また、気象の地上観測データは ARC 及び SAWS により提供されることを想定していたが、ARC からデータ提供の協力は得られなかった。SAWS についてはデータ提供に必要な契約に想定以上の時間がかかったが、2016 年 8 月に契約が締結され、データ入手可能な状況となっている。なお、地上観測データはダウンスケーリングされた気候予測性能検証に使用されたため、この遅延が SINTEX-F2 開発そのものには影響していない。 ・なお、SAWS はプロジェクト開始当初は外部協力機関であったが、2015 年 10 月の第 2 回 JCC でプロジェクトの実施機関として承認されている。

1-1-5. 公共建物に基本的気象観測ステーションを設置し、基礎的調査対象サイト内の局地的気象データを測定する。	・2015 年までに、ACCESS、LDOH-Malaria 及び熱研は、自動気象観測装置 7 台を調査重点地区であるグレーター・ギアニ域内の医療施設に設置し、気象観測を行っている。 ・なお、SAWS から得られる気象の地上観測データは南アフリカ全土をカバーしているのに対し、プロジェクトで設置した観測装置は調査重点地域の気象データを詳細かつ即時的に収集できる。
1-2. 対象疾患の罹患率/有病率、気候変動（気温、湿度、降雨量など）の関係性の解明	
1-2-1. 対象疾患の罹患率/有病率と気候変動の関連性を時系列分析により調査する。	・熱研と JAMSTEC は、1998 年以降のリンポポ州におけるマラリア患者数と気候との関連を複数の時系列統計手法を使って分析し、関係性があることを明らかにした。具体的には、マラリア患者数とモザンビーク及びジンバブエ南部の降水量及び西風との正の相関や、ペルー沖の海面温度との負の相関（ラニーニャとの正の相関）を明らかにしている。また、これらの関連性の季節ごとの解析も実施した。 ・肺炎と下痢症の発生件数と気候変動の関連については、データベースが完成し次第、ただちに調査を開始する予定である。しかしながら、保険会社から得られた民間医療施設の保険申請データを用いた相関関係の解析結果からは、収集されたデータの条件にバイアスが存在することを考慮しても、一定程度の相関関係の存在を示唆する結果を得ている。
1-2-2. マラリア媒介蚊と気候変動、そして、マラリア罹患率/有病率との関係を調査する。	・活動 1-1-3 で示したとおり、これまでにマラリア媒介蚊を解析が行える程度に採取できておらず、マラリア媒介蚊と気候変動や罹患率との関連についての解析は実施できていない。2016～2017 年シーズン以降で十分量のマラリア媒介蚊が採取でき次第、相関解析を実施する予定である。 ・なお、プロジェクトはザニンマラリア研究所（Tzaneen Malaria Institute：TMI）において人工環境装置を用いた気温と蚊の生育の関連性を調査する研究を 2015 年より開始した。研究結果はマラリア流行予測の数理モデル開発に使用される見込みである。
1-2-3. リンポポ州の局地気候変動と、エルニーニョ南方振動（ENSO）やインド洋ダイポールモード（IOD）、亜熱帯ダイポールモード（SDM）などの地球規模の気候変動現象との関連性を分析する。	・JAMSTEC は SINTEX-F2 を用い、リンポポ州を含む南部アフリカ地域の気候がラニーニャ現象とインド洋亜熱帯ダイポールモード及び亜熱帯ダイポールモードの影響を受けることを明らかにした。 ・また、JAMSTEC は気候観測データの解析から、南部アフリカ地域の降水量が季節変動や年々変動だけではなく、10 年規模でゆっくり変動していることを明らかにした。また、SINTEX-F2 を用いた解析により、この 10 年規模の変動は南太平洋から南インド洋に東進する海面気圧と海面水温の 10 年規模変動と強く相関していることが明らかとなった。 ・なお、プロジェクトは、上述の南部アフリカ地域での 10 年規模の気候変動とリンポポ州のマラリア患者発生件数との正の相関関係の可能性を指摘しており、中間レビュー時点では詳細な解析を実施している段階である。

1-3. リンポポ州の感染症流行状況を反映したマラリア、肺炎、下痢症の感染症数理もしくは、統計モデルの開発	
1-3-1. マラリアやコレラなどの既存の感染症モデル（特に気候に関連した）をレビューする。	・感染症発生件数の予測モデルには多くの手法があり、過去の感染症発生件数と気候データについて因果推論する統計モデルと、さまざまな現象（本件では感染症発生件数）を数式で表現することにより性質を推論する数理モデルがある。熱研と JAMSTEC は、マラリア、肺炎及び下痢症に関する既存の感染モデルのレビューを行った。 ・レビューの結果、肺炎及び下痢症に関しては、統計モデルが中心であった、一方、マラリアに関しては、ロス・マクドナルドモデル（マラリア流行の数理モデル）から派生した数理モデルが複数あり、そのなかでも最も新しい VECTRI モデルは、媒介蚊の生態も考慮しており、製作者とコンタクトし、プログラム情報を得た。
1-3-2. マラリア、肺炎、下痢症の基本的数理モデル及び統計モデルを改良または新規作成する。	・熱研と JAMSTEC は、マラリア感染件数の時系列及び空間解析を基に、リンポポ州の降雨量と気温を考慮したいくつかの統計モデルを開発した。また、上述の VECTRI モデルに気象因子を含めた数理モデルの開発を行った。 ・南アフリカ側の感染症流行モデル開発を担当する西ケープ大学（UWC）でも、日本側の研究と平行してマラリア流行の数理モデルの開発を行っている。これまでに 1 報の学術論文を国際誌に発表しており、1 報が審査中である。 ・2015 年 12 月に長崎にて熱研と JAMSTEC 合同のモデル開発セミナーを開催し、日本側研究機関（熱研、JAMSTEC、九州大学）のマラリア流行予測モデルの性能について検討した。なお、分散型ラグ非線形モデルに基づき二次感染者数の指標及び降雨量を考慮して作成したモデルでは、予測期間 3〜4 週間で毎週患者数の 75%値以上の上昇の予測精度 78%を達成している。 ・肺炎と下痢症に関しては、データベースが完成次第、統計モデルの開発を開始する予定である。
1-3-3. データベースで得られた感染症の後ろ向き及び前向きデータ/情報を用いてモデルの予測性能を検証し、モデルを調整する。	・マラリア流行予測モデルの開発を行っている熱研、JAMSTEC、UWC では、中間レビュー時点で後ろ向きデータを用いて予測性能の検証とモデルの調整を実施している。 ・肺炎、下痢症についても、データベースが完成次第、モデルの作成に引き続いて性能の検証、モデルの調整を実施する予定である。
1-4. 大気–海洋結合モデルを用いた短期気候変動予測システム（SINTEX-F）の高度化（予測精度の向上、予測情報の局地的な高解像度化、予測リード期間の長期化等）	
1-4-1. 空間高解像度化、物理スキーム改善、データ同化による初期化精度を向上させた新型の SINTEX-F を開発する。	・JAMSTEC は先行 SATREPS プロジェクトで開発した SINTEX-F に基づき、南極の海氷の影響を考慮し、高解像度化した新型の SINTEX-F2 を 2015 年に開発した。その結果、南インド洋で発生する亜熱帯ダイポールモード現象の予測精度が改善するとともに、南アフリカの夏期降水量の予測精度が向上した。 ・開発自体は終了しているが、今後も引き続き既存の気候モデル等との相互比較を継続し、予測スキルの向上を行う。
1-4-2. 既存の SINTEX-F や南アフリカの気候モデル等の相互比較を通して、短期気候変動予	

測モデルのバイアスを低下させる。	・また、南アフリカ側研究機関の CSIR 及び UP は JAMSTEC と平行して短期気候変動予測システムの開発を行っており、JAMSTEC との情報交換や技術交流によって改良を継続している。 ・なお、複数の予測モデルを集約し、両国のマルチモデルによるアンサンブル予測を配信するシステムの開発を行うことを双方合意している。
1-4-3. SINTEX-F の地球規模季節予測情報を、力学モデル（WRF）や統計手法を用いて局地的に高解像度化し（ダウンスケーリング）、その予測性能向上や予測期間の長期化を行う。	・JAMSTEC と CSIR は、SINTEX-F の地球規模季節予測情報を $10km^2$ の範囲を予測するダウンスケーリングに成功した。JAMSTEC と CSIR はその力学的ダウンスケーリングモデルの性能を共同で試験したところ、複雑な地形の影響を受ける南アフリカの気温や降水量に関する予測の精度が向上していることを確認した。 ・さらに、中間レビュー時点では SAWS の気象地上観測データが利用可能となったことから、中間レビュー以降も衛星からの観測データを基に地上観測データも使用して、更なる予測性能や予測リードタイムの向上に向けた研究を継続する。
1-4-4. 活動 1-4-3 と相互作用的に、対象地域の気候観測データ（活動 1-1 より）との相互比較を通して WRF モデルを高精度化する。	
1-5. 気候に基づいたマラリア、肺炎及び下痢症の感染症流行予測モデルの開発	
1-5-1. 活動 1-2 の対象疾患の罹患率/有病率、気候変動、ベクター間の関係性解析結果を踏まえ、感染症数理・統計モデルと改良気候変動予測システムを連結させて、気候に基づいた感染症流行予測モデルを作成する。	・熱研と JAMSTEC は、力学的ダウンスケーリングによって提供された気候予測データをマラリア流行予測モデルと連結させた「気候に基づいたマラリア流行予測モデル」の開発を 2016 年度より開始した。 ・2016 年 7 月に長崎にて熱研と JAMSTEC との間で「気候に基づいた感染症流行予測モデル」の進捗状況の確認や開発の具体的な実施手順や方向性について協議を行ったが、中間レビュー時点で連結したモデルに関する成果は出ていない。 ・また、中間レビュー時点では南アフリカ側研究機関と連結のための具体的な共同研究の進め方や、どのように連結を行うかなどについての協議は開始されていない。中間レビュー時に実施された Scientific Meeting を皮切りに、具体的な協議が開始される見込みである。
1-5-2. データベースで得られた過去数十年の感染症流行やアウトブレイクデータ/情報を用いてモデルの予測性能を検証し、モデルを調整する。	・ダウンスケールされた気候予測モデルと感染症流行予測モデルの連結は、連結の条件が確定できれば 2～3 カ月で完了できると見込まれており、「気候に基づいた感染症流行予測モデル」の開発をまずはマラリアを対象に実施する。 ・肺炎及び下痢症については、データベースが完成し、流行予測のための統計モデル開発が終了した時点で、予測データとの連結、過去のデータを用いた予測性能の検証と微調整を行う予定である。

成果 2
気候予測に基づいた感染性疾患流行早期警戒システム（iDEWS）の運用指針がリンポポ州で策定される。

活　動	達成事項
2-1. 流行予測を担当する組織や流行/警戒情報発出を担当する組織、情報に基づいて対策を行う組織などによるリンポポ州 iDEWS 導入準備委員会を立ち上げる。	・2015 年 10 月に iDEWS 導入準備委員会設立のための協議が開始され、南アフリカ側、日本側の研究機関間で開始した。2016 年 4 月には両国の研究者間で 2 回目の協議が行われ、運営規約（TOR）案や、委員会メンバーの選定等を実施している。 ・現時点では、LDOH（マラリア対策担当官、肺炎対策担当官、下痢症対策担当官を含む）、LDOH-Malaria、TMI、本プロジェクトに参加している南アフリカ及び日本の研究者が正式メンバーとしてノミネートされており、DOH の相当する担当官、国家災害管理センター（National Disaster Management Centre：NDMC）、南アフリカ公衆衛生協会（Public Health Association of South Africa：PHASA）及び法律顧問（Legal Advisor）を外部アドバイザーとする予定である。議長及び共同議長は第 1 回の準備委員会開催時に決定する予定としているが、中間レビュー時点で開催日程は決定していない。 ・プロジェクトでは、iDEWS がリンポポ州や将来的には国家レベルの既存の行政システム（サーベイランスシステムや災害対策システムなど）の一部として運営されることを想定していることから、iDEWS の開発は DOH や法律顧問のアドバイスの下で、実質的な iDEWS のユーザーである LDOH が主体的に実施することが期待されている。
2-2. アウトブレイク警戒情報発令の基準を設定する。 2-3. リンポポ州内の感染症流行/警戒情報伝達方法を設定する。 2-4. 定期情報伝達方法、アウトブレイク警戒情報発令と対策行動、情報伝達フォーマット、運用組織等を含む iDEWS 運用指針を作成する。	・想定していたリンポポ州の主要メンバーの異動や管理上の問題により、中間レビュー時点で LDOH や DOH、NDMC からのメンバーの最終的な確認を行っている段階である。当初予定では準備委員会は 2016 年 3 月までに設立され、警戒情報発令基準設定以降の活動は 2016 年 4 月から開始する予定であり、約半年の遅れが出ている。 ・メンバーが確定次第第 1 回 iDEWS 導入準備委員会をリンポポ州で開催し、感染症流行予測情報伝達方法（アウトブレイク警報を含む）、提供基準の設定などの運用指針の作成作業をマラリアから開始することになっている。肺炎、下痢症の iDEWS 運用指針作成についても、気候予測に基づく感染症流行予測モデル開発作業と並行して実施する予定である。

成果 3
iDEWS の予測性能と運用性が実証される。

活　動	達成事項
3-1. リンポポ州で iDEWS を試験運用し、iDEWS の予測性能及び運用性を評価する。	・iDEWS の試験運用（活動 3-1）及び机上訓練の実施（活動 3-2）、iDEWS のモニタリング評価システム作成（活動 3-3）は運用指針が完成した後に実施する予定である。

3-2. リンポポ州において、感染症アウトブレイク警戒情報発令と対策行動に係る机上訓練を実施する。	・当初計画では2017年4月から並行して活動開始することになっている。
3-3. iDEWS がリンポポ州の感染症対策に及ぼす影響を分析するための持続性のあるモニタリング評価システムを作成する。	
3-4. 利用可能な他州もしくは隣国の感染症流行データ、気候性及び非気候性環境データを用いて、iDEWS の適用性を検証する。	・活動 3-1～活動 3-3 の実施により iDEWS の予測性能と運用性が実証された後、他州や隣国への適用性の検証を実施する予定である。 ・当初計画では、2018 年 1 月より実施予定である。
3-5. 他州や隣国への iDEWS の展開に向けて、南アフリカや隣国の気候変動や感染症対策を担当する行政官、研究者等の関係者を対象としたワークショップを開催する。	・これまでにプロジェクトでは以下のようなシンポジウムやワークショップ等を実施した。 －キックオフ・シンポジウム（開催日時：2014 年 8 月 1 日、主催：ACCESS、場所：プレトリア、対象者：プロジェクト・メンバー及び関係者、参加者数：42 名） －ワークショップ（開催日時：2014 年 10 月 1 日、主催：LDOH-Malaria 及び SAMRC、場所：グレーター・ギアニ、対象者：LDOH 及び現地医療関係者、現地コミュニティ代表者、参加者数：32 名） －研究シンポジウム（開催日時：2015 年 1 月 1 日、主催：熱研、場所：長崎、対象者：南アフリカ及び日本のプロジェクト・メンバー及び関係者、参加者数：50 名）を開催した。なお、本シンポジウムには駐日南アフリカ大使も参加。 －研究シンポジウム（開催日時：2015 年 10 月 1 日、主催：ACCESS、場所：プレトリア、対象者：プロジェクト・メンバー及び関係者、参加者数：32 名） ・このほかにも、ACCESS 及び UL 共同主催による南アフリカ国内の修士課程の学生を対象にしたレクチャーシリーズ（3 日間）を 2015 年 10 月に開催した。 ・また、2015 年 1 月 28 日に開催されたシンポジウムに南アフリカ側研究者が来日した機会を活用し、翌日に開催された南部アフリカ開発共同体（Southern African Development Community：SADC）メンバー国大使定例会議にプロジェクト・メンバーがプロジェクトを紹介した。
3-6. 南アフリカの気候変動や感染症対策を担当する行政官、研究者等の関係者と他州への iDEWS 展開に向けた協議を開始する。	・研究成果や活動成果の取りまとめ作業と並行し、他州への適用に向けた活動を実施予定である。 ・当初予定では、2018 年 1 月より活動を開始予定である。

（2）成果の達成

1） 成果 1

成果 1 の達成度を以下に示す。

<table>
<tr><td colspan="2">【成果 1】
特にマラリア、肺炎、下痢症について、気候に基づいた感染症流行予測モデルが開発される。</td></tr>
<tr><td>指　標</td><td>達成度</td></tr>
<tr><td>1-1. 終了時評価時点までに、XX のような予測性能を有するマラリア iDEWS が開発されている。</td><td>・南アフリカ・日本国側双方の研究機関でマラリア流行予測モデルの開発が順調に進められている。
・同様に、南アフリカ・日本国側双方の研究機関で気候予測モデルの開発は順調に進められており、良好な予測精度を維持した状態でダウンスケーリングも成功した。
・気候予測とマラリア流行予測モデルの連結及び iDEWS としての開発作業はおおむね半年程度の遅延が認められているが、中間レビュー時点としての進捗としてはおおむね順調と考えられ、プロジェクト期間終了までに予定された活動は完了できる見込みである。</td></tr>
<tr><td>1-2. 終了時評価時点までに、YY のような予測性能を有する肺炎 iDEWS が開発されている。

1-3. 終了時評価時点までに、ZZ のような予測性能を有する下痢症 iDEWS が開発されている。</td><td>・中間レビュー調査時点で、リンポポ州の病院データのデータベース化が大きく遅延しており、肺炎、下痢症とも流行予測モデル開発が開始できていない。
・中間レビュー時点では、おおむね半年～1 年程度の遅れと考えられるが、保険会社から得た情報では、肺炎、下痢症とも気温及び降雨量との強い相関を示すデータを得ていることから、マラリア流行予測モデル開発のノウハウを活用して、流行予測のための統計モデル開発は比較的短期間で実施できることが見込まれている。
・指標 1-1 で示したとおり気候予測モデルはおおむね完成していることから、プロジェクト期間終了までの肺炎 iDEWS 及び下痢症 iDEWS 開発に向けて、研究活動を加速する予定である。</td></tr>
<tr><td>1-4. C/P 研究者である iDEWS、感染症数理・統計、短気気候変動予測システム、気候変動と感染症に関する学術論文が、ピアレビューのある国際専門誌にそれぞれ 4 報以上掲載されている。</td><td>・中間レビュー調査までに、既に iDEWS に関した論文 1 報、感染症数理・統計モデルに関した論文 2 報、短期気候変動予測システムに関する論文 11 報が審査のある国際専門誌に発表されている。
・中間レビュー時点で投稿中の論文もいくつかあり、中間レビュー以降も活動の進捗に従って更に多くの研究成果が創出され、国際的な学術誌等を通して発表されることが見込まれる。</td></tr>
</table>

JAMSTEC は CSIR と協力しながら、海氷を考慮した高解像度化した新型の大気–海洋結合モデルを用いた短期気候変動予測システム（SINTEX-F2）の開発に成功し、南部アフリカの気候予測の精度が大幅に向上した。また、SINTEX-F2 による地球規模季節予測情報の局地的高解像度化（ダウンスケーリング：約 10km^2 程度）にも成功している。これと並行して、南アフリカ側研究機関も気候予測モデルの開発を行っており、集合予測も含め、どのように感染症流行予測モデルに気候予測情報を提供するか具体的な検討を開始した段階である。

他方、感染症流行予測モデル開発に関しては、マラリアに関してはおおむね順調であるが、指標の達成度でも示したとおり肺炎及び下痢症については、病院データのデータベース化が当初計画より大幅に遅れていることから、流行予測モデル開発が開始できていない。しかしながら、民間病院の保険申請データや OTC 止瀉治療薬販売量データからは、肺炎、下痢症ともに気象データ（気温及び降水量）と一定の相関関係があることを示唆する予備試験結果も得られている。また、西ケープ州のデータから冬期の気温が 1℃上昇すると下痢症患者数が 20%上昇するとの予備的な分析結果が得られている。プロジェクトはこれらの知見を基に、中間レビュー以降のモデル開発研究を加速させ、2017 年 3 月頃をめどにすべての感染症流行予測モデルの開発を終了する予定である。

なお、これまでの研究成果は感染症流行予測モデル開発、気候変動予測システム開発に関連した学術論文を国際専門誌に 14 報発表している。今後はこれまでの研究テーマに加え、肺炎及び下痢症流行予測モデル開発や iDEWS 開発にかかわる実地研究（オペレーションズ・リサーチ)、蚊の生態などの研究の結果が蓄積されることから、今後も数多くの研究成果が学術誌に発表されることが見込まれる。

2） 成果 2

成果 2 の達成度を以下に示す。

【成果 2】
気候予測に基づいた感染性疾患流行早期警戒システム（iDEWS）の運用指針がリンポポ州で策定される。

指　標	達成度
2-1. 中間レビューまでに、iDEWS 運用準備委員会が立ち上げられている。	・これまでに iDEWS 導入準備委員会立ち上げに向けて南アフリカ側、日本側のプロジェクト実施機関で 2 回の事前協議が実施され、想定されるメンバー表や運用規約案が作成されている。 ・LDOH の主要メンバーの異動等もあり、中間レビュー時点では委員会メンバーの最終的な確認を行っている段階である。メンバーが確定次第、第 1 回委員会を開催し、議長及び協働議長の選定を行う予定である。
2-2. 2017 年 10 月までに、iDEWS 運用指針がリンポポ州の関係当局で検討されている。	・iDEWS 準備委員会の活動はおおむね半年程度の遅延が認められている。また、気象予測に基づいた感染症流行予測モデル開発は、特に肺炎、下痢症については半年～1 年程度遅延している状況である。 ・iDEWS 委員会が正式に活動開始した後は、順調に進捗しているマラリアから iDEWS 運用指針の作成作業を開始する予定である。

プロジェクトの前半は成果 1 の下で iDEWS の基礎となる研究成果の創出に南アフリカ・日本国側双方とも注力してきた。プロジェクトの 2 年目頃からは iDEWS 準備委員会の設立に向けた準備を徐々に開始したが、LDOH で本プロジェクトの窓口となる人材の異動等により、中間レビュー時点では委員会設立に向けた最終的な準備を進めているところである。しかしながら、委員会の運用規約が作成されていることから、メンバーが確定でき次第、プロジェクトは iDEWS 準備委員会の下で運用指針の完成に向けて活動を加速す

る予定である。なお、メンバーには LDOH が主体となり、LDOH-Malaria、TMI などのリンポポ州のメンバーに南アフリカ及び日本のプロジェクト研究機関が支援する形で運営される予定である。また、将来の他州への展開や iDEWS を行政システムの一部とすることを念頭に、DOH や NDMC 法律顧問なども外部サポーターとして参加する予定である。

他方、今後は研究開発から研究成果の社会実装のための活動にシフトする。主要なプレイヤーも LDOH をはじめとしたリンポポ州の保健関連の実務者となるため、プロジェクト全体としてはおおむね 6 カ月程度の遅れが出ていることも考慮し、より綿密なプロジェクト進捗管理が必要となる。

3） 成果 3

成果 3 の達成度を以下に示す。

【成果 3】
iDEWS の予測性能と運用性が実証される。

指　標	達成度
3-1. 2018 年 5 月までに、iDEWS の予測性能と運用性がリンポポ州での導入試験により評価されている。	・iDEWS 予測性能と運用性評価は運用指針が完成した後に実施する予定である。
3-2. 2019 年 2 月までに、iDEWS の他州や隣国を含む他の地域での適用性がしかるべき関係当局に提示されている。	・iDEWS の他州や隣国への適用に向けた関係当局との協議は、予測性能と運用性評価後に実施される予定である。 ・しかしながら、マラリア流行予測モデルの予測スキル向上と効果的な対策に向けて、プロジェクトはモザンビークの保健省及びマラリア対策センターと協力の可能性について協議を開始している。中間レビュー調査期間に開催される Scientific Meeting には、モザンビークから保健省公衆衛生局局長と他マラリア対策プログラムの責任者の参加も得ており、将来の iDEWS 適用も含めた協力に向けての関係構築が開始されている。

「成果 2 の達成度」で示したとおり、現時点では具体的な iDEWS 開発に向けた活動はリンポポ州で開始されておらず、中間レビュー以降はより綿密なプロジェクト進捗管理の下でプロジェクト活動が加速される必要がある。

他方、指標の達成状況に示したとおり、隣国への iDEWS 適用も視野に入れた協力の可能性についてモザンビークの関係当局と協議が開始されている。また、国内の他州への適用を念頭に、プロジェクトはマラリア患者の発生が報告されているムプマランガ州とクワズル・ナタール州について SAMRC が過去データの収集を開始しており、マラリア流行予測モデルの予測スキルをそれらの州のデータを使用してプロジェクト期間終了までに検証することも予定している。肺炎及び下痢症についても、西ケープ州とハウテン州のデータを保険会社から入手済みであり、他州への適用性の検証が可能である。

（3）プロジェクト目標の達成度

【プロジェクト目標】 南部アフリカへの適用に向けた先駆けとして、感染症対策のための気候予測に基づいた早期警戒システムモデルが確立される。	
指　標	達成度
1. プロジェクト期間終了までに、iDEWS、運用指針、運用コスト等が他の地域への展開に向けた先駆モデルとしてパッケージ化されている。	・これまでのプロジェクト活動全体としては、半年～1 年程度の遅延がある状況であることから、現時点でプロジェクト期間終了までに iDEWS 展開に向けたパッケージ化、南アフリカの感染症対策ツールとしての関係機関への提示が確実になされるかの見込み判断は困難である。
2. プロジェクト期間終了までに、iDEWS が（感染症対策の）ツールとして南アフリカの関係機関に提示されている。	

プロジェクト期間前半は、主に「研究」活動を主体とした技術面の確立が活動の中心であったが、中間レビュー以降はリンポポ州内での iDEWS 運用指針の作成や予測性能・運用性の確認、他州や隣国への展開のための iDEWS パッケージ化など、研究成果の社会実装（気候予測に基づいた感染症早期警戒システムの実用モデルとしての確立）のための活動が中心となる。そのため、プロジェクト活動はユーザーとなる LDOH 等南アフリカ側行政機関の強いリーダシップやオーナーシップが発揮されることが必要であり、同時に、6 カ月程度の遅れも認められることから、プロジェクト期間終了までにモデルの開発を 3 つの対象疾患すべてで達成するためには、厳格な進捗管理を行うことが求められる。

警報発令などの基準、予測情報に基づいた LDOH などの行政機関の対応、実際の iDEWS 運用の責任機関などは疾患ごとに異なる。また、特に肺炎や下痢症については、その原因によって取り得る対策などが異なる可能性もあり、流行予測に基づいた具体的な対応の基準、方法の決定は、感染症サーベイランス・レスポンスに十分な知識・経験を有した専門家の投入も必要となるかもしれない。

他方、本プロジェクトでは JICA 技術協力として南アフリカの感染症対策に資する具体的な結果を創出することと同時に、組織機能強化や人材育成を行うことも求められる。しかしながら、国際共同研究としての観点では南アフリカの研究機関の技術力は高く、イコール・パートナーとして共同研究を進めている。本プロジェクトでは中間レビューまでに既に気候変動予測モデル開発、感染症流行予測モデル開発で合計 14 報の学術論文を発表しており、今後も多くの論文が発表されることが見込まれている。このことは、SATREPS として研究成果を創出する目的にかなうだけでなく、間接的に両国の研究機関の研究能力の向上を示唆するものである。中間レビュー以降はこれらの研究成果に基づいて iDEWS 開発を行うことにより、リンポポ州の感染症対策や災害対策にかかわる実行力強化がなされることが期待される。

３－３　実施プロセスの検証

（1）プロジェクト活動の進捗

これまで示してきたとおり、気候変動予測モデル開発にかかわる共同研究は順調に進捗し

ており、これまでに既に 11 報の学術論文が国際専門誌に発表されている。ただし、南アフリカの外部協力機関として位置づけられていた ARC が所有する自動気象観測装置から地上観測データを入手することを想定していたが、実際にはデータ提供の協力を得ることができなかった。地上観測データは気候変動予測モデルの予測スキルの検証に使用するため、モデル開発には障害とはなっていない。中間レビュー時点ではリンポポ州内に設置したプロジェクトの自動観測装置やSAWSのデータが利用可能となったことから、リンポポ州内だけでなく、南アフリカ全土の地上気象観測データが利用できるようになっている。

これに対し、感染症流行予測モデル開発に関しては、マラリアについてはおおむね順調に進捗しているが、病院データのデータベース化が遅延し、そのデータを活用して実施される肺炎及び下痢症の流行予測統計モデル開発に半年～1 年程度の遅延が生じている。しかしながら、中間レビュー時点でデータベースの構築作業は終了に近づいており、プロジェクトの見立てでは 2107 年 3 月頃までには肺炎、下痢症それぞれについて流行予測モデルを開発できると見込んでいる。

他方、iDEWS 開発に向けた準備委員会の設立もリンポポ州本プロジェクトの窓口となっていた人材の異動等により、中間レビュー時点でメンバーの最終確定段階にあり、半年程度の遅れが生じている。

(2) プロジェクト管理と関係者間のコミュニケーション

実際の共同研究を行うために必要な南アフリカの研究機関が再検討され、プロジェクトが開始されてから現在までに NICD、SAWS、UP、UV がプロジェクトの実施機関に加えられ、NDMC、九州大学が外部協力機関となった。これにより、本プロジェクトの実施機関は外部協力機関を含め南アフリカ側で 14 機関、日本側 3 機関の合計 17 機関となった。

これは他の感染症分野の SATREPS プロジェクトのなかでも圧倒的に参画機関数が多く、連絡調整の困難さがうかがえるが、特に気象学研究グループの多くは過去の SATREPS プロジェクトから協力関係が継続されており、感染症研究グループとも南アフリカに駐在しているプロジェクト業務調整員（JICA 専門家）の丁寧な連絡調整管理により、円滑なコミュニケーションが維持されていることから、これまで適切なプロジェクト管理が実施されてきたと考えられる。

(3) オーナーシップ及び自立性

本プロジェクトに参加している南アフリカ側の研究機関、大学の研究開発能力は一定のレベルに達しており、日本研究機関とイコール・パートナーとして共同研究を進めている。しかしながら、スーパーコンピュータを使用した短期気候予測モデルや感染症流行予測モデル開発には日本の研究機関優位性もあり、南アフリカ側研究機関の本プロジェクトを通した技術開発、技術向上への意識は非常に高い。したがって、それぞれの研究機関がそれぞれの研究テーマで自立的に研究を進めながらも、カンファレンスなどの直接的な協議だけでなく、email や電話などで頻繁に技術的アドバイスや情報提供、研究成果に対する合同評価などを効果的に実施していることから、共同研究実施にかかわるオーナーシップ及び自立性は非常に高いと考えられる。

しかしながら、プロジェクト開始当初は一部の南アフリカ側研究機関と日本側研究機関の

間で、プロジェクトで実施する研究の内容・目的や進め方について認識の齟齬があった。プロジェクトが進捗するにつれて共通認識が得られるようになり、中間レビュー調査ではおおむね問題は解消している。

他方、前述のとおり、中間レビュー以降は気候変動に基づいた感染症早期警戒システムの開発を主導的に行うことから、LDOH をはじめとしたリンポポ州の行政機関のオーナーシップや自立性が今後強く発揮されることが求められる。なお、活動 3-5 で示したとおり、プロジェクトは中間レビューまでに南アフリカで多くの研究シンポジウム、ワークショップを行っている。また、リンポポ州で実施したレクチャーシリーズ等などもリンポポ州の関係機関の本プロジェクトの研究を理解する機会となり、iDEWS 開発やリンポポ州での導入に大きな関心と期待を寄せていることが確認されたため、リンポポ州行政機関の本プロジェクトへのコミットメントも期待できる。

第４章　評価結果

４－１　妥当性

プロジェクトの妥当性はこれまで高く維持されている。

（1）南アフリカにおける保健政策・科学技術政策やターゲットグループのニーズとプロジェクト目標の一致性

南アフリカを含む南部アフリカ諸国では感染症は依然として脅威であり、下痢症及び肺炎は南アフリカにおける 5 歳未満児死亡の上位 2 原因（それぞれ、21.4%、16.2%：2007 年）である[7]。マラリアについては他の南部アフリカ諸国と比べるとよく制御されているが、モザンビークやジンバブエなどのマラリア浸淫国に国境を接している南アフリカ北東部、特に本プロジェクトの対象地域であるリンポポ州は依然としてマラリア感染リスクにさらされている[8]。このような状況において DOH は「戦略計画 2015-2010」のなかで感染症対策の強化を国家プログラム「一次医療サービス」に位置づけ、感染症サーベイランスシステムの強化や国際保健規則（International Health Regulation : IHR）に沿った公衆衛生上の緊急事態への備えと対応能力強化を推進するとしている。また、南アフリカ政府は日本との科学技術協力の実施を重視しており、2014 年に DST と在南アフリカ日本大使館が共同で発表した“South Africa-Japan Cooperation in Science and Technology”のなかでも南アフリカでの科学技術協力における JICA の重要性や SATREPS の役割などが明記されるとともに、本プロジェクトの内容も紹介されている。

以上のことから、本プロジェクトを通じた南アフリカ・日本国側双方の研究機関の技術力向上や根拠（研究成果や新規知見など）に基づいた感染症対策を行う本プロジェクトの目的と南アフリカの保健政策、科学技術政策並びにニーズとの一致性は高く維持されている。

（2）日本の援助方針とプロジェクト目標の一致

わが国の ODA 方針においても感染症対策を重要視しており、2013 年 6 月の第 5 回アフリカ開発会議（TICAD V）で合意された「横浜宣言 2013」の具体的施策となる「横浜行動計画 2013-2017」でも感染症対策の重要性が改めて示されるとともに、気候変動に対する取り組みを多セクターで行うことの重要性も示されている。2016 年 8 月に実施された TICAD VI で採択された「ナイロビ宣言」では、「横浜宣言」及び「横浜行動計画」は 2019 年の次回 TICAD まで有効であることが確認されている。

また、TICAD VI に向けて外務大臣科学技術顧問によって作成された提言「科学技術・イノベーションの力でアフリカを豊かに」には、「人材育成を通じたアフリカの科学技術水準の向上」及び「研究開発の成果を社会全体へ還元」は、まさに SATREPS の理念と一致するものであることから、本プロジェクトはわが国の科学技術外交戦略に一致するものである。

したがって、気候変動予測に基づいた感染症早期警戒システムの確立をめざす本プロジェクトと、わが国の国際保健政策並びに科学技術外交戦略との一致性も高い。

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[7] UNDER-5 MORTALITY STATISTICS IN SOUTH AFRICA：Shedding some light on the trend and causes 1997-2007; April 2012, the Burden of Disease Research Unit, the South African Medical Research Council

[8] World Malaria Report 2015, WHO

(3) 気候変動予測に基づいた感染症対策に関する国際的要求について

WHO は地球温暖化などの気候変動が感染症など人の健康に対する影響について対策の必要性を明確に示している。特に“WHO Global Programme on Climate Change & Health”(2016)のなかで気候変動と健康に関する科学的根拠を得ることの重要性を示している。したがって、本プロジェクトを通じて気候変動とマラリア、肺炎、下痢症との相関関係や気候変動に基づいた感染症流行予測モデルの開発、予測情報に基づく行政的な対応などに関する科学的分析は、このような国際的要求にもかなうものと考えられる。

気候や気象に基づく感染症流行予測モデルの開発は学術的に多くの専門家により実施されているが、予測情報を実際の行政システムに活用している例はほぼなく、数カ月の予測期間で精度の高い局地的感染症流行予測モデルに基づいた感染症対策や災害対策が南アフリカで確立すれば、国際的に世界初の事例を提示することになる。

(4) 実施方法の適切性

1) 確定診断名でない「肺炎」及び「下痢症」を対象として iDEWS を開発することの論理的根拠

「肺炎」は肺の炎症性疾患の 1 つの状態であり、病原体の感染以外にも、薬剤性肺炎など感染以外の原因で発生する場合がある。同様に、「下痢症」も感染性、非感染性の原因で発生する。病原体もウイルスや細菌、真菌などさまざまな種類があり、それぞれの種類のなかでも、原因によっては予防対策や治療が異なる。つまり、肺炎や下痢を起こす原因は多種多様であり、発症にもさまざまな要因が影響することが考えられる。また、コレラ以外の下痢症は、マラリアのような災害レベルのアウトブレイクを起こすことはまれであり、通常の下痢症や肺炎は季節変動の範囲内で対応できる場合がほとんどである。このような条件下で、「果たして気候変動予測という限定的な要素が肺炎や下痢症の発生にどれだけ影響するのか」や「季節変動の範囲内での対応が主である疾患に対して、予測システムを用いた行政対応が必要なのか」などの疑問がレビュー・チームほか関係者内で惹起した。

これに対し、プロジェクトは予備的な分析ではありながらも、「肺炎」及び「下痢症」が気温や降雨量などの気候に強い相関があることを示唆するデータを得ており、また、冬期では 1℃の気温上昇で 20%の下痢症患者数の増加が起こることを示す分析結果を得ていることから、肺炎及び下痢症に対する iDEWS 開発の必要性を説明している。また、特に南アフリカの地方部ではコレラ以外の下痢症や肺炎の原因について通常は確定診断を得ることが困難であるため、「肺炎」や「下痢症」という疾患群診断名である。しかしながら、これら疾患群と気候変動の間に一定程度の因果関係が確認されたことから、マラリアに比較して圧倒的に患者数や死亡者数の多い肺炎、下痢症の患者数増加などの予測情報を保健局や医療施設が得ることは、都市部と比較して医療環境が劣る地方部では予防対策や備えを行ううえで重要であり、本プロジェクトで数カ月以上の予測期間で流行予測情報を得ることのニーズは非常に高いことが、LDOH などのリンポポ州の C/P だけでなく、南アフリカの研究者との面談調査を通じて確認された。

しかしながら、原因によって予防対策や治療法は異なることに変わりがないため、特に成果 2 の下で実施される運用規定の作成、特に関係者間で「肺炎」や「下痢症」をどのよ

うに定義し、流行予測情報に従ってどのような対応を行うかについては、当該分野の専門家の協力も得て、利用可能なエビデンスに基づき、リンポポ州の環境も考慮して慎重に決定されることが肝要である。

2) ジェンダーや民族、社会的階層、環境等に対する配慮

本プロジェクトはマラリア、下痢症、肺炎の流行予測に基づいた警戒システムの開発を行うものであり、直接的に感染性物質等を取り扱うことはないため、環境や専門家（研究者）の健康被害等に対する特別な配慮は要しない。

他方、南アフリカの研究機関の技術力は比較的高いが、地方の大学等では学生が先端的な研究に触れる機会は限定的である。プロジェクトでは修士課程の学生を対象にレクチャーシリーズを実施したが、開催場所はプロジェクトサイトであるリンポポ州とし、UL やジンバブエ国境付近の UV の学生が参加できるよう配慮した。

４－２ 有効性

以下の理由から、中間レビュー調査時点でのプロジェクトの有効性はおおむね高い。

(1) プロジェクト目標の達成見込み

プロジェクト目標の達成度で示したとおり、プロジェクトの前半では気候変動予測モデルの開発・改良や感染症流行予測モデル開発など、iDEWS の構築の基礎となる技術開発を中心に実施した。

特に気候変動予測モデルの開発については、SINTEX-F に南極の海氷の影響を考慮した改良を加えたことにより短期気候予測システムの高度化（SINTEX-F2 の開発）に成功した。SINTEX-F2 の開発は気候変動予測モデル開発の分野では、1 つのブレイクスルーといえる成果と考えられる。南アフリカ側でも独自の気候予測モデルの開発を日本側の直接的・間接的協力を得ながら実施しており、中間レビューまでに同分野で既に 11 報の学術論文が国際誌に発表されている。

他方、感染症流行予測モデル開発については、マラリアでは順調に進捗しているが、肺炎や下痢症については紙ベースの病院入院情報の電子化とデータベース化に遅れが生じており、中間レビュー時点でモデル開発に至っていない。しかしながら、既にマラリア流行予測モデル開発で 3 報の学術論文が国際誌に掲載されている。プロジェクトはデータベース化が完了できれば、マラリアでのモデル開発のノウハウを活用して肺炎及び下痢症の流行予測モデル開発は比較的短期間で実施できることを見込んでいる。

中間レビュー以降は、少なくとも数カ月の予測期間で一定の予測精度を保証するような気候予測モデルと感染症流行予測モデルの連結のための研究が速やかに進められることが見込まれており、気候変動に基づいた感染症流行モデル開発にかかわる研究成果も学術誌に多く投稿されることが見込まれる。また、このように数多くの学術論文が国際誌に掲載されたことは、南アフリカ・日本国側双方の研究機関の機能強化や研究者の能力強化を間接的に証明していると考えられる。

このように、これまでに多くの研究成果が得られ、研究機関の組織機能強化、人材育成も達成していると考えられることから、中間レビュー時点でのプロジェクトの有効性は、特に学術的側面で非常に高いと考えられる。

しかしながら、本プロジェクトの目標は根拠に基づいた感染症対策のための気候予測に基づいた早期警戒システムモデルを開発することであることから、プロジェクト全体の有効性を担保するためには、中間レビュー以降に本格的に実施される「研究成果の社会実装」の成功が必要である。プロジェクト全体としては約半年、計画からの遅れが認められることから、プロジェクト期間終了までに予定した活動を完遂するには、より厳密な進捗管理が求められる。また、特に肺炎及び下痢症の iDEWS 開発には、「４－１　妥当性」で示したとおり、可能な限り専門性と十分な経験を有する専門家の協力の下で、根拠に基づいた運用指針の作成が行われることが必要である。

(2) 成果及びプロジェクト目標達成のための外部条件

成果達成のための外部条件「プロジェクトの外部協力機関（DOH、SAWS、ARC、公共建物管理者等）から、プロジェクト活動の実施に必要な協力が得られる」の現状

活動 1-1-4 に示したとおり、気象の地上観測データは ARC 及び SAWS により提供されることを想定していたが、ARC からデータ提供の協力は得られなかった。SAWS についてはデータ提供に必要な契約に想定以上の時間がかかったが、2016 年 8 月に契約が締結され、データ入手が可能な状況となっている。なお、地上観測データはダウンスケーリングされた気候予測の予測精度検証に使用されたため、この遅延が SINTEX-F2 開発そのものには影響していない。

なお、SAWS 及び NICD はプロジェクト開始当初は外部協力機関だったが、2015 年 10 月の第 2 回 JCC でプロジェクトの実施機関として承認されている。

(3) 有効性への促進要因

本プロジェクトには実施機関だけで非常に多くの機関（合計 15 機関）が参加しているが、気候変動予測モデル開発にかかわる研究グループ、感染症流行予測モデル開発にかかわる研究グループともに、email や電話などを通して頻繁に連絡、協議等が行われている。このことは遠く離れた南アフリカと日本で共同研究が順調に実施され、上述したような研究成果が得られたことの一因と考えられる。

(4) 有効性に対する阻害要因

病院入院情報の電子化とデータベース化については、南アフリカ側の投入で実施されることで合意していた。紙ベースの入院情報約 28,000 件を電子化し、更にデータベース化するには相当な労力が必要であり、そのための外注費の分配が必要だったが、南アフリカ側でそのための予算が使用できるようになるまでに予想以上の時間を要した。

このことにより、肺炎及び下痢症の感染症流行予測モデルの開発作業が大きく遅延し、本件は有効性に対する阻害要因と整理できる。

(5) その他

プロジェクト開始後、DOH、LDOH 及び CSIR のプロジェクト・メンバーが異動となり、プロジェクトを離れた。それに伴い、新たなメンバーに対して協力関係を構築するために日本側プロジェクト・メンバーは一定の努力と時間を要した。また、プロジェクトの研究活動

に参加していた南アフリカの若手研究者数名に入れ替えがあったが、プロジェクト・メンバーの努力によってプロジェクト活動実施に対する負の影響は回避されている。

また、南アフリカでは蚊の密度がそれほど高くなく、加えて、エルニーニョ現象の影響もあり野生の蚊の捕獲数が減少し、蚊の生態や殺虫剤耐性などの研究は十分できていない。しかしながら、マラリア流行予測モデル開発には蚊の生態に関する情報が必須ではないため、これまでのモデル開発への影響はほぼない。今後、蚊の研究が進捗すれば、漸次、モデルの改良に生かされる見込みである。

４－３　効率性

予期しない外部要因により一部の研究活動に遅延が生じたため、中間レビュー時点でのプロジェクトの効率性は中程度である。

(1) プロジェクト活動の進捗管理

本プロジェクトは 2014 年 5 月に開始のための MOU に署名がなされたが、南アフリカ（リンポポ州及びプレトリア）に駐在する 2 名の長期専門家（それぞれ研究者、業務調整員）の着任が同年 10 月となった。そのため、実質的なプロジェクト活動の開始は同年 10 月からとなり、研究機器の導入やデータ収集活動開始に若干の遅延が生じた。また、南アフリカ側研究機関間の共同研究実施のための MOU 締結に想定以上の時間を要し、気象地上観測データの入手などに遅延が生じた。

特に、これまで示してきたとおり、南アフリカ側の病院入院データのデータベース化のための予算が利用できるようになるのが 2016 年に入ってからとなったため、肺炎及び下痢症の流行予測モデル開発が中間レビュー時点で開始されておらず、おおむね半年から 1 年程度の遅延と考えられる。また、iDEWS 準備委員会の設立も LDOH の主要なメンバーの異動等により中間レビュー時点でメンバーの最終化を行っている段階である。本件も当初予定から約半年程度の遅延である。

しかしながら、プロジェクト運営としては中間レビューまでに実施された 2 回の JCC に加え、南アフリカ・日本国側の双方で実施されたシンポジウムの機会及び日常的な email や電話会議等で、研究の進捗や成果創出状況の管理はおおむね適切に実施されてきたと考えられる。このことは、「４－２　有効性」の項で示したとおり、プロジェクト活動としては半年～1 年程度の遅延が認められながらも、中間レビュー時点で多くの研究成果を創出していることで説明できる。遅延の原因はプロジェクト外部の要因であったが、特に南アフリカ側 C/P は活動予算確保や iDEWS 組織化に最大限の努力を行っており、これまでの進捗管理そのものに大きな問題があったわけではない。

とは言え、中間レビュー以降は肺炎及び下痢症の流行モデル開発を加速させるとともに、気象予測モデルと感染症流行モデルの連結作業と予測期間及び予測精度の検証などの研究活動に並行して、いよいよリンポポ州においてこれら研究成果の社会実装（iDEWS 運用指針の作成や運用性の検証など）へとプロジェクト活動はシフトする。つまり、プロジェクトの実施者もこれまでの研究者に加え、リンポポ州の行政組織が主体的に活動することとなる。また、iDEWS は将来的には感染症サーベイランスや災害対策のメカニズムに組み入れられることを念頭においていることから、iDEWS 適用に向けたプロジェクト活動は南アフリカの法

的・倫理的基準に沿って実施される必要がある。以上のことから、中間レビュー以降はより厳密な進捗管理、成果管理を行うことが強く求められる。

(2) 提供された機器及び材料の有効利用

南アフリカ側の既存の研究機器を最大限に活用して研究活動が実施されており、本プロジェクトでの研究機器等の導入はそれほど多くないが、中間レビューまでに、予定された研究機器の整備導入はおおむね終了した。

使用目的や環境によって使用頻度に差はあるが、導入された研究機器等はプロジェクトの活動のために使用されており、維持管理も適切に実施されていることが確認されている。

(3) 本邦研修で獲得した知識・技能の有効利用

これまでに 3 名の南アフリカ側若手研究者が日本の研究機関で短期の研修を受講した。獲得した知識や技術は特に中間レビュー以降のデータ収集作業や分析に活用される見込みである。

中間レビュー以降も本邦研修で若手研究者数名を日本の研究機関へ派遣することが予定されている。特に気候変動予測グループからは、南アフリカにとって新しい全球海洋モデル化技術を習得予定で、習得した技術は南アフリカの他の研究者に共有されることが予定されている。また、感染症流行予測モデルグループからも、南アフリカ側で作成したモデルと日本側のモデルを比較検討することによって、モデルの微調整を行う予定である。

(4) 外部リソースとの連携

1) 最新のマラリア流行予測数理モデル（VECTRI モデル）の共同開発

日本側研究機関は VECTRI モデルの情報（ソースコード）を開発者（イタリア人研究者）より提供を受け、共同で改良を行っている。本モデルは蚊の生態も考慮に入れて予測を行うものであり、本プロジェクトで開発したマラリア流行予測モデルのなかでも最も有力なモデルの 1 つとして認識される。

2) マラリアサーベイランスシステム向上に向けた現地 NGO との連携

マラリア流行予測モデルの予測スキル検証やマラリア iDEWS の効果的な運用には、元情報となるサーベイランスシステムが適切に機能することが必要である。リンポポ州のマラリアサーベイランスシステム向上に向けて、プロジェクトは当初、熱研がケニアで実施している SATREPS プロジェクトで確立した携帯電話を用いた感染症報告システムをリンポポ州に適用することを検討しており、リンポポ州で開催されたシンポジウムでも同プロジェクトの専門家を招へいし講演を実施した。

しかしながら、その後、同州でクリントン財団の支援を受けた現地 NGO が同様のシステムを用いた報告システム向上のための支援を開始したため、本プロジェクトでは活動の重複回避、活動の効率化を念頭にケニアのシステムの導入は行わず、現地 NGO と協力、側面支援して現地マラリア報告システムの向上を行うこととした。上記した報告システムによって、マラリア患者発生情報は 24 時間以内に TMI にも報告されるようになった。TMI は報告に基づき、ただちに周辺住民に対する非症候性マラリアの調査を実施できるようになった。

3） マラリア自動診断装置の開発公益社団法人グローバルヘルス技術振興基金の資金援助を得て、産業技術総合研究所、パナソニック株式会社、熱研が共同で新型マラリア自動診断装置の開発を進めており、ほぼ完成の状態である。プロジェクトでも試験導入を検討している。

本装置は既存の簡易診断キット等よりも操作が簡便で精度・特異度とも高く、電池やソーラーパネルで駆動する。2016 年 8 月にケニアで開催された TICAD VI でも紹介され、注目を集めている。

(5) 効率性に対する促進要因

これまで示してきたとおり、本プロジェクトに実施機関として参加している南アフリカ側研究機関は 15 機関である。これらの機関はプレトリア、リンポポ、ダーバン、ケープタウンなど南アフリカの広範囲に点在している。

このような環境でありながらも、南アフリカに駐在している JICA 専門家（業務調整）は南アフリカ・日本間だけでなく、南アフリカ内の研究機関間の連絡調整を綿密に実施しており、双方の研究機関による信頼も厚く、円滑な共同研究の運営管理に大きく貢献していると考えられる。

(6) 効率性に対する阻害要因

南アフリカ側のある実施機関は学生等に対する人材育成等に関しては大きなコミットメントがなされたが、諸事情により分担されていたある研究活動が主体的に実施されず、南アフリカに駐在する日本人研究者（JICA 専門家）が代わりに実施することによって、プロジェクトの進捗に対する負の影響を回避することができた。

本件は、同機関からプロジェクトに対して必要な投入が実施されなかったとの観点から、本プロジェクトの効率性を一定程度阻害したと考えられる。

４－４ インパクト

プロジェクトの実施によって、以下に示す正のインパクトが確認または期待されている。

(1) 想定される上位目標達成の可能性

SATREPS では上位目標の設定は必ずしも必要とされていない。しかしながら、SATREPS は研究成果の社会実装を強く意識した事業であり、プロジェクト目標にも「南部アフリカへの適用に向けた先駆けとして」と、感染症対策のための気候予測に基づいた早期警戒システムモデルがプロジェクト期間終了後に南アフリカの自助努力によって他地域に適用されることを念頭においている。

南アフリカのマラリアの多くはモザンビークやジンバブエの国境付近で発生していることから、プロジェクトは対象サイトをリンポポ州としている。これまでの研究により、リンポポ州でのマラリア患者数はモザンビーク南部及びジンバブエ南部の降水量と 3 カ月のラグで正の相関があることが明らかとなった。また、リンポポ州でのマラリア患者には一定の割合で隣国からの流入があることも示唆されており、マラリア流行予測モデルの予測スキル向上にはモザンビークなど隣国の情報も解析できることが望ましい。プロジェクトは既にモザ

ンビーク保健省や同国マラリア対策プログラム担当官と協力の可能性について協議を開始している。研究面での協力が得られれば、将来的にはより患者数の多いモザンビーク等へのiDEWS 適用なども可能性が高まるものと考えられる。

しかしながら、南アフリカの他州や隣国への適用を実現するには、プロジェクト期間内でiDEWS が行政システムの一部として機能することを証明することが必要であるとともに、他地域への適用に向けたリソース分析（人材、コスト、時間など）と運用指針も含めたパッケージ化を完了することが必要である。中間レビュー時点ではプロジェクト全体としておよそ半年程度の遅延が認められており、厳密な進捗管理、成果創出管理の下で、プロジェクト活動を加速させる必要がある。

(2) その他の正のインパクト

1) 南部アフリカの降水量の 10 年規模変動とマラリア患者数の関連

活動 1-2-3 で示したとおり、JAMSTEC は気候観測データの解析から、南部アフリカ地域の降水量が季節変動や年々変動だけではなく、10 年規模でゆっくり変動していることを明らかにした。また、SINTEX-F2 を用いた解析により、この 10 年規模の変動は南太平洋から南インド洋に東進する海面気圧と海面水温の 10 年規模変動と強く相関していることが明らかとなった。

この発見を基に、プロジェクトは南部アフリカ地域での 10 年規模の気候変動とリンポポ州のマラリア患者発生件数との正の相関関係について中間レビュー時点で過去のデータを用いて詳細な解析を実施中である。これが証明できれば、南部アフリカで気候変動に基づく感染症流行予測モデル開発や具体的な行政的予防対策に大きな正のインパクトをもたらすと考えられる。

2) データベース化された病院入院データの他の研究への活用

南アフリカでは特に地方部の病院の入院データが電子化され、更にデータベース化された例はない。データベース化には多くの時間や費用、労力を要したが、データベースは肺炎や下痢症などの特定の疾患情報を集めたわけでなく、全データをデータベース化しているため、その情報は本プロジェクトにおける肺炎及び下痢症の流行予測モデル開発だけでなく、感染性疾患、非感染性疾患に限らず多くの後ろ向き医学研究に活用できるため、非常に付加価値の高い成果物ととらえることができる。

実際に、プロジェクトに参加している博士課程の学生が心臓血管系疾患の研究に同データベースを活用することを検討している。

3) ザニンマラリア研究所（TMI）の機能強化

TMI に JICA 専門家（疫学・医用昆虫学）1 名が駐在し、長期にわたる共同の日常業務や研究活動を通じて、マラリア媒介蚊の研究を行うための施設設備の強化や研究技術移転がなされ、同所の機能強化、スタッフの能力強化が図られている。

具体的には、プロジェクトの実施によってグレーター・ギアニ地区をセンチネル・サイトとした成虫のマラリア媒介蚊サーベイランスシステムが確立した。同地区では蚊の採取やトラップの保守点検は同地の住民をアルバイト雇用して実施しているが、プロジェクト期間終了後も TMI によって維持されることが見込まれている。また、マラリア媒介蚊の幼虫サーベイランスは通常業務として実施されていたが、具体的な実施方法の改善や実施マ

ニュアル、記録様式、標準操作手順書（SOP）などの作成、改訂が実施された。さらに、人のマラリアサーベイランスについても、TMI は初発症例（Index Cases）周辺の住民 7 世帯に対する能動的サーベイランス（非症候性マラリア感染の調査）を行うことになっているが、同専門家の支援により、調査実施の SOP や記録様式の作成、改善を行った。現在はグレーター・ギアニ地区での活動が確立されているが、今後は他の地区へも非症候性マラリアの調査を拡大することを計画している。

(3) 負のインパクト

本プロジェクトの実施に起因する負のインパクトは、中間レビュー時点において確認されていない。

４－５　持続性

プロジェクトによって生み出された便益の自立発展、自己展開は中間レビュー時点においても一定程度見込まれる。

(1) 政策的、制度的側面

「４－１　妥当性」の項でも述べたとおり、南アフリカにおいて気候変動予測モデルや感染症流行予測モデル開発の技術力を高めながら、関連した研究成果に基づいた（根拠に基づく）感染症対策を行うことの政策的重要性はプロジェクト期間終了までのみならず、終了以降も継続することが強く見込まれるため、本プロジェクトの政策的持続性は中間レビュー時点においても一定程度期待できる。

また、上述のとおり、本プロジェクトでは根拠に基づく感染症対策としてマラリア、肺炎、下痢症に対する iDEWS の確立をめざしている。また、プロジェクトは iDEWS を将来的には他州や隣国への展開も視野に入れた活動を行っていることから、そのためには iDEWS がリンポポ州で感染症サーベイランスシステムや災害対策のメカニズムの一部として機能することをプロジェクト期間終了までに証明する必要がある。

したがって、プロジェクトは iDEWS を行政システムの一部として運用することを念頭に、DOH や NDMC などの国家機関や法律顧問の助言を得ながら、慎重に制度化に向けた活動を実施することが求められる。

(2) 財政的側面

プロジェクトの研究活動は、日本も含めて一般的には組織独自の研究予算のみで実施することは不可能で、競争的研究資金など外部組織からの支援を獲得するための継続的な努力を行う必要がある。そのため、中間レビュー時点で研究継続のための財政的持続性を評価することは困難である。

他方、上述のとおり iDEWS が感染症サーベイランスシステムや災害対策メカニズムの一部となれば、行政システムとして継続運営のための予算は担保されることが見込まれる。また、プロジェクトは iDEWS が将来的には南アフリカの他州や隣国で適用されることを念頭においていることから、プロジェクト活動の一部として運用コスト分析なども含めたパッケージ化を行うこととしているため、継続運営のための予算計画に必要な情報はプロジェクト

より提供される予定になっている。

(3) 技術的側面

プロジェクトでは中間レビュー後ただちに気象予測モデルと感染症流行予測モデルの連結を行うことで、「気候に基づいた感染症流行予測モデル」の開発を行う。ただし、気象予測、感染症流行予測とも複数のモデルが中間レビューまでに南アフリカ・日本国側双方の研究機関で開発されており、これらのモデルをどのように連結させるか（そのようなデータセットが必要か、目的や条件によって使用するモデルを選択するのか、アンサンブル予測を行うのか、など）については、今後、関係機関間で詳細な検討が実施される予定である。しかしながら、iDEWS に提供する予測情報を出すために複数の気候変動予測モデル及び複数の感染症流行予測モデルを使用するとなった場合には、前向きデータを用いたモデルの微調整も含めて、南アフリカ側にすべてのモデルを引き継ぐ必要がある。したがって、プロジェクトは南アフリカ側研究機関がモデルの維持・向上を行うことが現実的であるか、あるいは、最低限の予測スキルを維持しながらモデルを統合するなどの簡素化をめざすのかなど、方向性について中間レビュー以降ただちに関係者間で協議がなされることが求められる。

他方、iDEWS に関する技術的持続性に関しては、州もしくは国の行政システムの一部としての運用を念頭においていることから、一定の持続性は担保されるはずである。しかしながら、そのためには、リンポポ州の行政組織等の機能や役割、医療環境も考慮に入れた実現可能性の高い運用規定を作成することが求められる。

４－６　結論

本プロジェクトは南アフリカ・日本の共同研究により科学的に重要な知見を生んでおり、その成果によってマラリア、下痢、肺炎の感染症対策に貢献することが期待される。

中間レビュー時点にて、妥当性と有効性は高く評価できる。妥当性は、南アフリカ・日本国側双方の科学技術政策及び感染症サーベイランスシステムの強化や世界保健規則（IHR）に沿った公衆衛生上の緊急事態への備えと対策能力強化といった南アフリカ保健省政策に合致している。有効性については、感染症予測モデルはマラリアで順調に開発されており、下痢症や肺炎においても関係者の協力の下、データが整理され気候との関係が解析されつつある。

効率性については中間レビュー時点では、外部要因により当初の予定より遅れがみられる活動が確認されたが、関係者の努力により研究の遅れは取り戻されつつあり、中程度であると考えられる。また、持続性については、プロジェクトによって生み出された便益の自立発展や広域展開は中間レビュー時点においても一定程度見込まれる。また、プロジェクトは学術的な成果に加え、特に南アフリカ・日本国側双方の若手研究者や学生の人材育成に大きな成果を生んでいる。

なお、南アフリカと日本の研究機関の共同研究において、特に新規開発した短期気候変動予測システム（SINTEX-F2）を用いた研究から、以下のような重要な科学的知見を得ている。①南部アフリカ地域の降水量は季節変動や年々変動だけではなく、10 年規模でゆっくり変動しており、②この変動が南太平洋から南インド洋に東進する海面気圧と海面水温の 10 年規模変動と強く相関していることが明らかとなった。③これに関連し、リンポポ州でのマラリア患者数はモザンビーク南部及びジンバブエ南部の降水量と 3 カ月のラグで正の相関がみとめられた。④また気候と下痢症の関連性に関する初期的な解析から、iDEWS が下痢症に対して適用できる可能性を示した。

第５章　提言と教訓

５－１　提言

中間レビューの結果に基づき、合同レビュー・チームは以下のとおり提言する。

（1）iDEWS の開発について

・中間レビュー以降は研究成果の社会実装（気候予測に基づいた iDEWS を 感染症対策実用モデルとしてリンポポ州内で確立）のための活動が中心となる。iDEWS はリンポポ州もしくは南アフリカの感染症サーベイランスシステムや災害対策メカニズムなど既存の行政システムの一部として運用されることが想定されることから、DOH や NDMC、法律顧問などの外部アドバイザーの協力を得て、LDOH、LDOH-Malaria、TMI 及び南アフリカと日本の研究機関は iDEWS 準備委員会として適切な協力関係を構築していくこと。

・南アフリカの他州や隣国への適用に向けて iDEWS のパッケージ化を行う際には、リンポポ州での試験運用に基づく iDEWS 運用のためのコスト（人、物、金、時間）についても分析を行うこと。

・警報発令基準の設定、予測情報に基づいた行政対応、システム運用の責任機関などは疾患ごとに異なる。また、疾患の原因となる病原体によって予防対策方法や治療などの対応が異なることも想定される。したがって、プロジェクトは iDEWS 運用指針作成に感染症サーベイランス・レスポンスに十分な知識・経験を有した専門家の追加投入も検討すること。

（2）肺炎と下痢症に関する iDEWS の開発について

・肺炎及び下痢症に関しては、病院入院患者データベース構築の遅れにより、プロジェクト工程に 6 カ月～1 年程度の遅れが認められることから、プロジェクト期間終了までにモデルの確立を 3 つの対象疾患すべてで達成するためには、厳格な進捗管理を行うこと。

・両疾患の発生率は気候との相関関係が認められている。また、南アフリカではマラリアに比して圧倒的に患者数や死亡者数が多いため、iDEWS を構築することについて一定の意義は認められる。しかしながら、疾患の種類や原因によって予防対策や治療法は異なるため、関係者間で両疾患をどのように定義するかについて共通理解を醸成すること。また、流行情報に基づいた具体的対応について、当該分野の専門家の協力も得ながら、エビデンスに基づき、リンポポ州の環境も考慮して慎重に iDEWS 準備委員会で協議を行うこと。

（3）持続性の確保

・「気象に基づいた感染症流行予測モデル」を構成する「気象予測モデル」「感染症流行予測モデル」はともに複数のモデルが開発されているが、それらモデルはプロジェクト期間終了までに南アフリカ側研究機関に引き渡され、プロジェクト期間終了後は南アフリカ側でモデルの微修正を含めて維持・管理が継続されることが必要となる。プロジェクト終了後も iDEWS が南アフリカで継続的に活用されるためには、その際にモデルの引き継ぎを念頭に統合や簡素化も含め、プロジェクト期間終了後のシステム維持に向けた具体的な検討を開始すること。

・共同で研究を実施していくことにより南アフリカ側研究者の人材育成を継続すること。ま

た、中間レビュー以降は iDEWS 開発のためのプロジェクト活動を通じて、プロジェクトはリンポポ州における感染症サーベイランスシステムの強化のための人材育成も可能な限り実施すること。感染症サーベイランス情報の精度向上は、感染症流行予測モデルの予測精度向上にも貢献する。

(4) 他州や隣国への適用に向けた気候に基づく感染症流行予測モデルの適用可能性の検証

・本プロジェクトは南アフリカ内だけでなく、南部アフリカ諸国に対する iDEWS の適用も視野に入れている。既にリンポポ州と国境を接するモザンビークの関係当局と協議が開始されているが、プロジェクトは利用可能なデータ等を活用し、他国または国内の他州への適用可能性について検証すること。

５－２　教訓（和文のみ）

本プロジェクトは SATREPS の枠組みで実施されており、プロジェクトで生み出された研究成果を社会実装することを強く意識している。実際に、プロジェクトの前半は iDEWS の基礎となる研究成果の創出に重点がおかれ、後半ではそれらを基に対象州での iDEWS 適用を行うことが予定されている。

具体的には、本プロジェクトは協力期間内に研究成果（iDEWS）の社会実装に向けた運用性や適用性の検証を実施することを計画しており、それに伴ってプロジェクトの実施も研究機関に加えて iDEWS のユーザーである行政機関（DOH や州保健局、NDMC など）が主体的にプロジェクトを実施する必要がある。しかしながら、本プロジェクトのデザインの段階（詳細計画策定調査時）に DOH や州保健局との緊密な協力関係の構築の必要性が事前評価表で指摘されていたが、中間レビュー調査時点ではそれらの機関を中心に構成される iDEWS 準備委員会の組織化に想定以上の時間と労力を要し、プロジェクトの遅延の一因となっている。

これまでの期間でプロジェクトから得られる教訓としては、プロジェクトの協力期間のなかで研究成果の社会実装に向けた具体的な準備活動をプロジェクト活動に含むことは SATREPS の原則に沿うものであるが、研究者ではない研究成果のユーザー（行政組織等）による社会実装に向けた研究成果の検証等をプロジェクト活動の一部とする場合は、プロジェクトは実際の検証作業が開始される前にしっかりとした協力関係、実施体制を構築できるよう、進捗管理を厳密に行うことが必要である。

第６章　PDM の修正

2016 年 10 月 4 日に開催された第 3 回 JCC でプロジェクト・チームより PDM version 1（2014 年 8 月 6 日）の修正が提案され、version 2（別添 6）として承認された。
変更内容と変更後の指標の説明を以下に示す。

	変更前	変更後
成果 1 の指標	(1) 終了時評価時点までに、XX のような予測性能を有するマラリア iDEWS が開発されている。	(1) 終了時評価時点までに、マラリアのアウトブレイクの予測確率を 3 カ月前に提供する早期警戒警報システムが開発されている。予測性能は過去の予測値と実測値との一致率が最低 60%を目標とする。
	(2) 終了時評価時点までに、YY のような予測性能を有する肺炎 iDEWS が開発されている。	(2) 終了時評価時点までに、肺炎の季節変化を 3 カ月前に予測する早期警戒警報システムの開発可能性を示す。予測性能は過去の予測値と実測値との一致率が最低 60%とする。
	(3) 終了時評価時点までに、ZZ のような予測性能を有する下痢症 iDEWS が開発されている。	(3) 終了時評価時点までに、下痢症の季節変化を 3 カ月前に予測する早期警戒警報システムの開発可能性を示す。予測性能は過去の予測値と実測値との一致率が最低 60%とする。

マラリアに対する iDEWS 開発に関して、プロジェクトは終了時評価時点までにマラリアのアウトブレイクの予測確率を 3 カ月前に提供する早期警戒警報システムが開発されていることを目標とし、マラリアの予測モデルはアウトブレイクの予測確率を基に評価する。過去の一定期間の患者数の 50、75、90 パーセンタイル値などあらかじめ定義した閾値以上の患者発生をアウトブレイクと定義する。予測性能は過去の予測値と実測値との一致率で評価する。一致率は過去の一定期間の総予測件数に占める正しくアウトブレイクの有無を予測した件数とする。一致率は最低 60%を目標とする。

また、肺炎及び下痢症に対する iDEWS 開発に関しては、終了時評価時点までに、肺炎及び下痢症の季節変化を 3 カ月前に予測する早期警戒警報システムの開発可能性を示すことを目標とし、予測モデルは季節変化の予測確率を基に評価する。季節変化の指標は患者数増加の始まる時期またはピークの時期とする。予測性能は過去の予測値と実測値との一致率で評価する。一致率は過去の一定期間の総予測件数に占める正しく季節変化を予測した件数とする。一致率は最低 60%を目標とする。

付　属　資　料

１．協議議事録（MM）及び中間レビュー報告書

別添 1．PDM version 1（2014 年 8 月 6 日）

別添 2．中間レビュー調査の日程

別添 3．評価グリッド

3-1　実施プロセスの検証

3-2　評価 5 項目

別添 4．主要面談者リスト

別添 5．投入実績表

5-1　プロジェクト・メンバー表

5-2　JICA 専門家派遣

5-3　南アフリカ人研究者来日

5-4　本邦研修

5-5　現地研修

5-6　供与機材リスト

別添 6．PDM version 2（2016 年 10 月 4 日）

MINUTES OF MEETINGS
BETWEEN
THE JAPANESE MID-TERM REVIEW TEAM
AND
THE AUTHORITIES CONCERNED OF
THE GOVERNMENT OF THE REPUBLIC OF SOUTH AFRICA
ON
THE JAPANESE TECHNICAL COOPERATION PROJECT FOR THE ESTABLISHMENT OF AN EARLY-WARNING SYSTEM FOR INFECTIOUS DISEASES IN SOUTHERN AFRICA INCORPORATING CLIMATE PREDICTIONS

The Japanese Mid-Term Review Team (hereinafter referred to as "the Team"), jointly organized by Japan International Cooperation Agency (hereinafter referred to as "JICA"), headed by Dr. Kaname Kanai, visited the Republic of South Africa (hereinafter referred to as "South Africa") from the 18th of September to 4th of October, 2016, for the purpose of the Mid-Term Review of the project, entitled "The Establishment of an Early-Warning System for Infectious Diseases in Southern Africa incorporating Climate Predictions" (hereinafter referred to as "the Project").

During its stay in South Africa, the Team had a series of discussions with the the authorities concerned of South Africa and both sides agreed on the matters referred to in the Minutes and Attached Document which summarizes the Joint Mid-Term Review Report attached hereto.

Pretoria, 4th October, 2016

Dr. Kaname Kanai
Team Leader
Mid-Term Review Team
Japan International Cooperation Agency
Japan

Dr. Neville Arendse
Chief Director
Overseas Bilateral Cooperation,
Department of Science and Technology
The Republic of South Africa
for:
Dr. Isayvani Naicker
Chief Director:
International Relations, Department of Science and Technology
The Republic of South Africa

Witnessed by;

Dr. Noboru Minakawa
Professor
Nagasaki University
Japan

Mr. Ben Durham
Chief Director,
Bio-Innovation, Department of Science
and Technology
The Republic of South Africa

Ms. Manti Maifadi
Deputy Director
Office of the Chief Director:
Communicable Diseases, National
Department of Health
The Republic of South Africa

Dr. Neville Sweijd
Director
Applied Centre for Climate and Earth
Systems Science
The Republic of South Africa

Attached Document

Through the discussions regarding the progress and performance of the Project among the Team, JICA experts and South Africa counterparts of the Project and other organization concerned, the Team compiled the results of the Mid-Term Review as a Joint Mid-Term Review Report attached hereto. Both South Africa and Japanese sides agreed the contents of the Joint Mid-Term Review Report containing conclusions and recommendations as follows.

1. Conclusions

Based on the points listed below, it is considered that the progress and achievement of the Project Purpose as of the time of the Mid-term Review are appropriate in general.

1) As of the time of Mid-Term Review, the Project has produced many research outcomes which lead to the establishment of the infectious disease early warning system (iDEWS). The iDEWS is expected to contribute for the infectious disease control of malaria, diarrhea, and pneumonia.

2) The Project can be highly evaluated in terms of relevance and effectiveness. For the relevance, there are high consistencies with both South African and Japanese policies on the science and technology as well as the international health policies such as the International Health Regulations. For the effectiveness of the Project, the development of prediction models for malaria incidence is on the process of the verification. Inpatient data has been registered into database through the efforts of the members and will be ready to analysis with climate factors.

3) The efficiency of the Project is moderate owing to the unexpected external factors, which caused delays in several research activities but those are managed through efforts of the project team as of the time of the Mid-term Review. The sustainability is expected to be high since the Project provides the sustainability as well as a border deployment. In addition to the scientific achievements, the Project has achieved significant human resource development, especially for young researchers and students in both South Africa and Japan.

4) South Africa – Japan collaborative research has produced some important findings obtained through the newly developed SINTEX-F2 seasonal climates prediction system and analysis of real climates observation as follows; 1)

decadal change in the rainfall (precipitation) in the area of southern Africa on top of the annual or seasonal change; 2) a strong correlative relationship between the said decadal change of rainfall and other decadal change in sea surface temperature as well as pressure that moves eastward from the South Atlantic Ocean to the South Indian Ocean; 3) in this regard, the Project points out that the possibility of positive correlation between the decadal climate change in southern Africa and the malaria incidence in the Limpopo province with 3-month time lag; and 4) preliminary analyses of climate drives diarrhea show potential successful application of iDEWS

2. Recommendations

(1) Development of iDEWS

- After the time of the Mid-term Review, the Project will focus on the activities for the practical application of the research outcomes to society (i.e., the establishment of the climate-based iDEWS as a practical model in the Limpopo province). It is envisaged that the iDEWS is operated as a part of the administrative system such as infectious disease surveillance system and/or disaster management system in the Limpopo province and/or the national level; therefore, the Project should develop a proper collaborative relationship among iDEWS preparatory committee members such as the Department of Health-Limpopo (DOHL), the DOHL-Malaria, the Tzaneen Malaria Institute and South African and Japanese research institutes, with the support of the external advisors such as the national Department of Health, the National Disaster Management Centre and the legal advisor.

- The Project should perform resource analyses (human resource, necessary materials, costs and timeframe) for the operation of iDEWS based on the test operation in the Limpopo province when the Project develop an iDEWS package for the application to other provinces in South Africa and neighboring countries.

- The setting of alerting criteria, the administrative countermeasures based on the prediction information, and the responsible organization for the operation of iDEWS can be different in accordance with diseases. Likewise, it is envisaged that the way of prevention and control as well as treatment can vary in accordance with causative pathogens. Therefore, the Project should consider additional input of

expert(s) with sufficient knowledge and experiences of infectious disease surveillance and response for the development of the operational guidelines of iDEWS.

(2) Development iDEWS for pneumonia and diarrhea

- Since the development of iDEWS for pneumonia and diarrhea is lagging behind schedule by approx. 6 to 12 months as of the time of the Mid-term Review due to the delay in developing database of hospital inpatient information, the Project should strengthen the progress management to complete the establishment of iDEWS for all 3 target diseases by the end of the project period.

- Pneumonia as well as diarrhea has a correlative relationship with climate. Besides, the incidence and casualty of pneumonia as well as diarrhea are overwhelmingly higher than that of malaria in South Africa. Therefore, the rationale of the development of iDEWS for pneumonia and diarrhea is secured. Having said that, since the prevention measures as well as treatment will be different in accordance with the type of diseases and/or causative pathogens, project members should reach a common understanding of the definition of "*pneumonia*" as well as "*diarrhea*". Further, the Project, at the initiative of the iDEWS preparatory committee, should carefully discuss evidence-based concrete countermeasures in accordance with the prediction information with the support of specialist(s) in consideration of the context in the Limpopo province.

(3) Securement of sustainability

- The Project developed several models for each "climate prediction model" as well as "infectious disease epidemic prediction model" for linking them up to develop a "climate-based infectious disease epidemic prediction model". Some of the said models are supposed to be handed over to the South African research institutes; thereafter, maintained and even fine-tuned by themselves. In order for the iDEWS to be utilized continuously in South Africa, the Project should start discussions among relevant organizations on the maintenance of iDEWS; simplification or unification of the models can be one option.

- The Project should continue the capacity building of South African researchers through the collaborative research. In parallel, the Project is expected to raise capacity of project members in the Limpopo province for the reinforcement of infectious disease surveillance system through the project activities for the

development of iDEWS after the time of the Mid-term Review. The accuracy improvement of the information from the infectious disease surveillance will also contribute to the improvement of the performance of infectious disease epidemic prediction models.

(4) Verification of applicability of the climate-based infectious disease epidemic prediction models in light of the application to other provinces and neighboring countries

- The Project intends to apply the iDEWS not only to other provinces in South Africa but also southern African countries in future. The Project has already commenced discussions with the authorities concerned in Mozambique, sharing the border with the Limpopo province; however, the Project should verify the applicability of iDEWS to other provinces and/or neighboring countries using currently-available data.

Attachment : Joint Mid-Term Review Report

Attachment 1

JOINT MID-TERM REVIEW REPORT

ON

THE JAPANESE TECHNICAL COOPERATION PROJECT

FOR

ESTABLISHMENT OF AN EARLY-WARNING SYSTEM FOR INFECTIOUS DISEASES IN SOUTHERN AFRICA INCORPORATING CLIMATE PREDICTIONS

UNDER THE SCHEME OF

THE SCIENCE AND TECHNOLOGY RESEARCH PARTNERSHIP FOR SUSTAINABLE DEVELOPMENT (SATREPS)

Japan International Cooperation Agency (JICA)

and

Authorities concerned in the Republic of South Africa

4 October 2016

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ABBREVIATIONS

ACCESS	Applied Centre for Climate and Earth Systems Science
AMED	Japan Agency for Medical Research and Development
ARC	Agricultural Research Council
CSIR	Council for Scientific and Industrial Research
DST	Department of Science and Technology
DOH	Department of Health
DOHL	Department of Health-Limpopo
DOHL-Malaria	Department of Health-Limpopo, Malaria Control
GIS	Geographical Information System
GPS	Global Positioning System
iDEWS	(Climate Prediction-based) infectious Diseases Early Warning System
IHR	International Health Regulation
IRS	Indoor Residual Spraying
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JST	Japan Science and Technology Agency
LAMP	Loop-mediated Isothermal Amplification
M/M	Minutes of Meetings
MOU	Memorandum of Understanding
MRC	South African Medical Research Council
NDMC	National Disaster Management Centre
NEKKEN	Nagasaki University Institute of Tropical Medicine
NGO	Non-Governmental Organizations
NICD	National Institute for Communicable Diseases
ODA	Official Development Assistance
OVIs	Objectively Verifiable Indicator(s)
PCM	Project Cycle Management
PDM	Project Design Matrix
SADC	Southern African Development Community
SATREPS	Science and Technology Research Partnership for Sustainable Development
SAWS	South African Weather Service
SOP	Standard Operating Procedure
TICAD	Tokyo International Conference on African Development
TMI	Tzaneen Malaria Institute
UCT	University of Cape Town
UL	University of Limpopo
UP	University of Pretoria
UV	University of Venda
UWC	University of the Western Cape
WHO	World Health Organization
WRF	Weather Research and Forecasting
ZAR	Zuid-Afrikaans Rand

CHAPTER 1 SCOPE OF MID-TERM REVIEW

1.1 Background of the Mid-term Review

It is suggested that the epidemic of certain infectious diseases such as malaria, diarrhea and pneumonia can be affected by climate variability, in particular, air-sea interactions such as La Niña effect, seasonal variability of ambient temperature and precipitation. Southern African countries including the Republic of South Africa (hereinafter referred to as "*South Africa*") are being subject to danger of the said infectious diseases. As was just described, the relationship between climate variability and the incidence of infectious diseases is strongly suggested; nevertheless, its concrete correlative relationship has not been scientifically proven. For this reason, climate-based infectious disease epidemic prediction has not been used for practical measures for infectious diseases control to this date.

On the other hand, a climate variability prediction system with high prediction accuracy (SINTEX-F) was developed through the collaborative research of the South African and Japanese research institutes with the support of a former JICA's technical cooperation entitled "*the Project for Prediction of Climate Variations and its Application in the Southern African Region*" (2010 – 2013), which was implemented under the scheme of the Science and Technology Research Partnership for Sustainable Development (hereinafter referred to as "*SATREPS*"). On the basis of the said project, "*the Project for Establishment of an Early-Warning System for Infectious Diseases in Southern Africa incorporating Climate Predictions*" (hereinafter referred to as "*the Project*") is launched in May 2014 under the scheme of SATREPS, aiming to further improve the prediction skill of the SINTEX-F, followed by the establishment and subsequent operability verification of climate variability-based infectious disease early-warning systems (hereinafter referred to as "*iDEWS*"), especially for malaria, diarrheal diseases and pneumonia.

The Joint Mid-term Review will be conducted jointly with authorities concerned of the South African side to review performance and achievements of the Project, and to provide recommendations to offer solution against current challenges as well as a direction of the Project for the rest of the project period.

1.2 Objectives of the Mid-term Review

The objectives of the Mid-term Review are as follows:

1) To review the interim progress of the Project and evaluate the achievement as of the time of the Mid-term Review in accordance with the five evaluation criteria ('*Relevance*', '*Effectiveness*', '*Efficiency*', '*Impact*' and '*Sustainability*') on the basis of latest version of Project Design Matrix (PDM) version 1 (Annex 1);
2) To discuss the contributing and hindering factors for the achievements of the Outputs and the Project Purpose;
3) To discuss the plan for the Project for the rest of the project period together with the South African side based on reviews and analysis of the project performances;
4) To make recommendations in order to achieve the Project Purpose and future Super Goal, and to revise the PDM as necessary basis; and
5) To summarize the results of the study in a Joint Mid-term Review Report.

1.3 Joint Review Team

The review of the Project was jointly performed by three (3) South African members and three (3)

JICA members. The members of the Joint Review Team (hereinafter referred to as "*the Team*") were indicated below.

Simultaneously with the JICA's review work, the Japan Agency for Medical Research and Development (hereinafter referred to as "*AMED*")[1], supporting research activities conducted in Japan under the framework of SATREPS, dispatched two (2) members and participated in the field survey in South Africa to conduct their final evaluation and to offer technical advices on the research activities from technical standpoint.

<The Japanese Side >

Name	Designation	Title and Affiliation	Duration of Survey
Dr. Kaname KANAI	Leader	Executive Technical Advisor to the Director General, Human Development Department, JICA	24/Sep/2016 – 4/Oct/2016
Ms. Saya UCHIYAMA	Cooperation Planning	Staff, Health Team 2, Health Group 1, Human Development Department, JICA	30/Sep/2016 – 5/Oct/2016
Dr. Yoichi INOUE	Evaluation Analysis	Senior Consultant, Consulting Division, Japan Development Service Co., Ltd.	18/Sep/2016 – 5/Oct/2016

<The South African Side >

Name	Title and Affiliation
Dr. Isayvani NAICKER	Chief Director, International Relations, Department of Science and Technology
Mr. Ben DURHAM	Chief Director, Bio-Innovation, Department of Science and Technology
Ms. Manti MAIFADI	Deputy Director, Office of the Chief Director, the Department of Health

Not according to seniority

<AMED Mission Members>

Name	Designation	Title and Affiliation	Duration of Survey
Prof. Dr. Haruo WATANABE	Infectious Diseases Control Research	Program Officer, International Collaborative Research Program, Department of International Affairs, AMED Professor, the Graduate School of the International University of Health and Welfare	28/Sep/2016 – 4/Oct/2016
Mr. Katsumi ISHII	Planning and Evaluation	Deputy Manager, Division of International Collaboration, Department of International Affairs, AMED	28/Sep/2016 – 4/Oct/2016

The on-site review work was conducted from the 19th of September to the 4th of October 2016. This evaluation included site visits, interviews and scrutinizing various documents and data related to planning, implementation and monitoring processes of the Project (Annex 2).

1.4 Framework of the Project

The framework of the Project is described below.

1) Five (5) years from the 12th of May 2014 to the 11th of May 2019.

[1] Affairs under the jurisdiction and authorities of the projects in the field of infectious disease control was transferred to AMED. The transfer took place on the 1st of April, 2015.

2) The administration system of the Project is as follows:

- The Chief Director of the Biotechnology, the Department of Science and Technology (hereinafter referred to as "*DST*") is assigned as the Project Director;
- The Chief Director of the Communicable Diseases, the Department of Health (hereinafter referred to as "*DOH*") is assigned as the Project Co-Director[2];
- The Director of the Applied Centre for Climate and Earth Systems Science (hereinafter referred to as "*ACCESS*") is assigned as the Project Manager; and
- The Professor of the Department of Vector Ecology and Environment of the Nagasaki University Institute of Tropical Medicine (hereinafter referred to as "*NEKKEN*")

3) Project Implementers (research institutes) of the Project are indicated as follows:

The South African Side: ACCESS; the South African Medical Research Council (MRC); The Council for Scientific and Industrial Research (CSIR); the National Institute for Communicable Diseases (NICD)[3]; the South African Weather Service (SAWS)[4]; the Department of Health-Limpopo; the Department of Health-Limpopo, Malaria Control (DOHL-Malaria); the University of Cape Town (UCT); the University of Limpopo (UL); the University of Pretoria (UP)[5], the University of Venda (UV)[6]; and the University of the Western Cape (UWC)

The Japanese Side: NEKKEN and the Japan Agency for Marine-Earth Science and Technology (hereinafter referred to as "*JAMSTEC*")

4) The direct and indirect beneficiaries of the Project are 46 researchers of the South African project implementers and approximately 5.4 millions of peoples living in the Limpopo province, respectively.

5) The Narrative Summary of the Project:

The Narrative Summary of the Project (Project Purpose, Outputs and Activities) set in the latest PDM (version 1), authorized at the 1st Joint Coordinating Committee (hereinafter referred to as "*JCC*") held on the 6th of August 2014, is described below.

Please refer to the Annex 1 (PDM version 1) for other elements of PDM such as the Objectively Verifiable Indicators (OVIs), means of verification, the Inputs from both sides to the Project, the Preconditions and the Important Assumptions.

Narrative Summary of PDM version 1

Project Purpose	A climate-based early-warning system model for infectious diseases control is established as a precursor for further application across southern Africa.
Outputs	Output 1 Climate-based infectious disease epidemic prediction models are developed especially for malaria, pneumonia and diarrhea. Output 2

[2] Replaced from the Chief Director of the District Health Services, the NDOH. Accordingly, the Memorandum of Understanding (hereinafter referred to as "*MOU*") dated on the 12th of May 2014 was amended by exchanging the Minutes of Meetings (hereinafter referred to as "*M/M*") between the DST and JICA on the 10th of November 2015.

[3] The NICD was authorized as a South African member of the Project at the time of the 2nd JCC held in October 2015.

[4] The SAWS was authorized as a South African member of the Project from an external supporting organization at the time of the 2nd JCC held in October 2015.

[5] The UP was authorized as a South African member of the Project at the time of the 1st JCC held in August 2014.

[6] The UV was authorized as a South African member of the Project at the time of the 1st JCC held in August 2014.

	Operational guidelines of the climate prediction-based infectious diseases early warning system (iDEWS) are developed in the Limpopo Province. Output 3 Prediction performance and operability of the iDEWS are verified.
Activities	Activities under Output 1 1-1. Prospective and retrospective data/information acquisition systems are developed in the areas of infectious diseases and climate variability 1-1-1. To develop databases of data/information of malaria, pneumonia and diarrhea respectively from local health information system, archival records of health facilities and so on. 1-1-2. To determine investigation target sites on the basis of a risk map for respective diseases, which is developed using retrospective data from the database. 1-1-3. To conduct fact-finding surveys at communities in the targeted sites with regard to incidence and prevalence of respective diseases (including undiagnosed diseases), residents' behavior that impacts on the prevalence (health seeking behavior, etc.) and hygienic environment (water quality, air pollution, malaria mosquito insecticide resistance etc.), followed by populating the data into the database. 1-1-4. To source climatic and non-climatic ancillary environmental data (geographic data, etc.) from ACCESS partner organizations such as the South African Weather Service (SAWS) and the Agricultural Research Council (ARC). 1-1-5. To observe local-scale meteorological data in the target sites by placing basic observation stations at public buildings. 1-2. Elucidation of relationships among incidence/prevalence of the target diseases and climate variability (ambient temperature, humidity, precipitation, etc.). 1-2-1. To investigate the relationship between incidence/prevalence of the target diseases and climate variability using time-series analysis. 1-2-2. To investigate the relationships of proliferation of malaria vectors with climate variability and malaria incidence/prevalence. 1-2-3. To investigate the relationship between regional-scale climate variations in the Limpopo Province and their links with the global climate phenomena such as the El Nino Southern Oscillation (ENSO), the Indian Ocean Dipole Mode (IODM) and the Sub-tropical Dipole Mode (SDM). 1-3. Development of infectious disease mathematical and/or statistical models for malaria, and statistical models for pneumonia and diarrhea of which local epidemic situation is reflected 1-3-1. To review existing infectious disease models (related to climate in particular) for malaria, cholera, and pneumonia. 1-3-2. To develop basic mathematical and/or statistical models for malaria, and statistical models for pneumonia and diarrhea by modifying existing model(s) or newly developing. 1-3-3. To calibrate the models by verifying their prediction performance using retrospective and prospective data/information of infectious diseases obtained from the database. 1-4. Improvement of a seasonal prediction system based on an ocean-atmosphere coupled general circulation model (CGCM) called SINTEX-F; improving its skill, downscaling, extending its lead-time 1-4-1. To improve the prediction accuracy of SINTEX-F for the short-term seasonal climate variability by enhancing model resolution, implementing better physics and data assimilation in next versions of SINTEX-F on the Earth Simulator. 1-4-2. To reduce model biases by model validations and intercomparisons among SINTEX-F1, new SINTEX-F2 and other climate models developed in South Africa. 1-4-3. To improve resolution and lead time for climate prediction of the SINTEX-F for better local-scale prediction performance by using a dynamical downscaling model such as Weather Research and Forecasting model (WRF) and statistical downscaling techniques. 1-4-4. Interactively with the Activity 1-4-3, to fine-tune WRF downscaling model

	using local data available from the weather and climate observations at the target areas (Activity 1-1). 1-5. Development of the climate-based infectious disease prediction models for malaria, pneumonia and diarrhea 1-5-1. To develop a climate-based infectious disease epidemic prediction models for malaria, pneumonia and diarrhea by coupling the infectious disease mathematical and statistical models and the adopted climate prediction model, in light of the relationships among incidence/prevalence of the target diseases, climate variability and proliferation of vectors (Activity 1-2). 1-5-2. To calibrate the models by verifying their prediction performance using existing data/information of infectious diseases epidemics and outbreaks obtained from the database. <u>Activities under Output 2</u> 2-1. To launch a preparatory committee for introducing the iDEWS at the Limpopo Province consisting of organizations responsible for epidemic prediction, issuing epidemic/alerting information and implementing countermeasures based on such information. 2-2. To set criteria for outbreak alerting. 2-3. To set communication flow of infectious diseases epidemic/outbreak information in the Limpopo Province. 2-4. To develop an iDEWS operational Guidelines comprising regular reporting of epidemics, issuing outbreak alerting and consequent countermeasures, organogram of iDEWS operation, formats of regular reporting and alerting, etc. <u>Activities under Output 3</u> 3-1. To evaluate the prediction performance and operability of the iDEWS through a pilot application at the Limpopo Province. 3-2. To conduct table-top exercises regarding issuing outbreak alerting and consequent countermeasures at the Limpopo Province. 3-3. To develop a sustainable monitoring and evaluation system for assessing impacts of the iDEWS on infection control at the Limpopo Province. 3-4. To verify the applicability of other areas using available data of epidemics, climate and non-climate environment at other provinces of the South Africa and neighboring countries. 3-5. To hold workshop(s) geared to administrative officers, researchers, etc. in the areas of climate variability and infection control from the government of the South Africa and neighboring countries for the deployment of iDEWS. 3-6. To start discussions with administrative officers, researchers, etc. in the areas of climate variability and infection control of the government of the South Africa for the dissemination of iDEWS.

CHAPTER 2 METHOD OF THE MID-TERM REVIEW

2.1 Framework of Project Review under SATREPS

Since SATREPS provides assistances to the counterpart countries through the implementation of technical cooperation project on site by JICA and the technical and financial support for research works in Japan by AMED in a collaborative manner, it is natural that review and evaluation works on site are conducted in tandem in consideration of its efficiency.

JICA, jointly with governmental organizations and/or research institutes including researchers, will review and evaluate the performance and achievement of the technical cooperation project implemented under the framework of the Japan's ODA from the viewpoint of human resource development, capacity development, and contribution to development agenda at partner countries. AMED will evaluate the whole of international joint research works from the viewpoint of research outcomes that contribute to resolve the global issues.

2.2 Methodology of Review

The Mid-term Review was performed in accordance with the latest "*JICA Guidelines for Project Evaluation Second Edition*" and "*JICA Handbook for Project Evaluation (Ver. 1)*" issued in May 2014 and August 2015, respectively. Achievements and implementation process were assessed based on the investigation results, which are consolidated in the evaluation grid (Annex 3), from the aspects of the five evaluation criteria of relevance, effectiveness, efficiency, impact, and sustainability, as well as the Verification of Implementation Process.

The Team conducted surveys at the project sites through questionnaires and interviews to counterpart researchers, other related organizations, and the JICA experts involved in the Project to review the Project on the basis of the evaluation grid. See Annex 4 "*List of Interviewees*" for more information.

Project performances including achievement of the Objectively Verifiable Indicators (OVIs) were reviewed and analyzed in accordance with the Project Cycle Management (PCM) concept. The review work was jointly performed by the Japanese and the South African sides on the basis of PDM version 1 (See Annex 1 for more information). Finally, the Team compiled this Joint Mid-term Review Report.

2.3 Five Evaluation Criteria

Description of the five evaluation criteria that were applied in the analysis for the Mid-term Review is given below.

Five Criteria	Description
Relevance	Relevance of the Project is reviewed by the validity of the Project Purpose and Overall Goal in connection with the government development policy and the needs in the South Africa. Relevance of the Project is verified on the basis of facts and achievements at the time of the Mid-term Review.
Effectiveness	Effectiveness is assessed to what extent the Project has achieved its Project Purpose, clarifying the relationship between the Project Purpose and Outputs. Effectiveness of the Project is verified on the basis of facts and achievements at the time of the Mid-term Review.
Efficiency	Efficiency of the Project implementation is analyzed with emphasis on the relationship between Outputs and Inputs in terms of timing, quality and quantity. Efficiency of the Project is verified on the basis of facts and achievements at the time of the Mid-term Review.
Impact	Impact of the Project is assessed in terms of positive/negative, and intended/unintended influence caused by the Project. Impact of the Project is verified in accordance with the necessity and possibility at the time of the Mid-term Review.
Sustainability	Sustainability of the Project is assessed in terms of political, financial and technical aspects by examining the extent to which the achievements of the Project will be sustained after the Project is completed. Sustainability of the Project is verified on the basis of extrapolation and expectation at the time of the Mid-term Review.

CHAPTER 3 PROJECT PERFORMANCE

3.1 Inputs

1) Input from the Japanese Side

The following are inputs from the Japanese side to the Project as of the end of June 2016. See Annex 5 for more information.

Components	Inputs
Dispatch of Japanese Experts	Long-term Experts: a total of 2 Experts (Epidemiology/medical entomology research and Project Coordinator), 42 M/M (Man/Month) Short-term Experts: a total of 14 Experts, 13.8 M/M (415 days in total)
Provision of Equipment	Major Items: Automatic Weather Observation System, research / laboratory instrument and related equipment such as microscopics, artificial environment test system, personal computers for data processing and analyses, software for data analyses, etc. (JPY 33,730,933 (≒ approx. ZAR 3,815,716 ≒ YY USD 290,909) [7]
Invitation of Researchers from Abroad (Training in Japan)	Total number: 12 persons Content: Discussion of the research direction and methods regarding the prediction of climate variability in Southern Africa (2 persons, a total of 18 days), and the participation and presentation at the project open symposium (10 persons, a total of 80 days)
Training in Japan	Total number: 3 persons Content: - Theory and practice of statistical methods for the development of the Geographical Information System (GIS)-based infectious diseases risk mapping (2 persons at NEKKEN for 22 days) - Theory and practice of statistical methods for correlation analyses between the incidence of infectious diseases and meteorological data (1 person at JAMSTEC for 21 days)
Local costs	Overseas activities costs: JPY 12,035,061 (≒ USD 103,795, ≒ ZAR 1,361,432) [8] – JFY2014: JPY 3,899,227 – JFY2015: JPY 5,930,234 – JFY2016: JPY 2,205,600 (estimated amount)

2) Input from the South African Side

The followings are inputs from the South African side to the Project as of the end of June 2016. See details on the Annex 5.

Components	Inputs
Allocation of Counterpart Researchers	A total of 46 researchers (1 from ACCESS; 12 from MRC; 6 from CSIR; 1 from NICD; 6 from SAWS; 1 from DOHL; 2 from DOHL-Malaria; 3 from UCT; 6 from UL; 2 from UP; 4 from UV; and 2 from UWC0
Facilities, Equipment and Materials	1. Project office spaces in CSIR and DOHL-Malaria; 2. Laboratory space un DOHL-Malaria; 3. Existing research instruments, equipment and/or devices in the South African counterpart organizations; 4. Available data, information and/or specimens related to the Project; and 5. Availability of teleconference system in CSIR
Local costs	Costs for field survey in the Limpopo province, the development of database for hospital inpatients information, domestic transportation of the South African counterpart personnel, utilities for the project office, consumables used for the project activities, custom clearance of the materials procured in Japan such as research instruments and reagents, etc.

[7] JICA Conversion rates at each year was used for currency conversion.
[8] JICA Conversion rates at each year was used for currency conversion.

3.2 Achievements of the Project

1) Achievements of the Project Activities

Achievements of the Project Activities under Outputs are as indicated below.

Output 1 Climate-based infectious disease epidemic prediction models are developed especially for malaria, pneumonia and diarrhea.	
Activities	Performances
1-1. Prospective and retrospective data/information acquisition systems are developed in the areas of infectious diseases and climate variability	
1-1-1. To develop databases of data/information of malaria, pneumonia and diarrhea respectively from local health information system, archival records of health facilities and so on.	• The Project, at the initiative of the DOHL-Makaria and the NEKKEN, gathered malaria incidence data in the Limpopo province from the year of 1998 when rapid diagnosis test kits were introduced for the diagnosis of Malaria into a database. Data of new malaria cases are being added to date. • Data collection of pneumonia and diarrhea incidents – The Project, at the initiative of the MRC and the CSIR, are still working on the registration of all inpatients information of the Nkhensani Hospital in the Greater Giyani (approx. 28,000 cases, 2002 to 2016). The collected data will be subjected to data cleaning for secure its quality. The Project estimated that the development work of the database will be completed by October 2016. Since the database contains all hospital inpatient data, the number of pneumonia or diarrhea cases cannot be counted during the development work of the database as of the time of the Mid-term Review. – The Project also gained inpatient data from a hospital in Phalaborwa, and is adding it to the database. – The ACCESS obtained information of insurance claims with the diagnosis of pneumonia as well as diarrhea from the insurance company by their own efforts (approx. 60,000 – 80,000 cases). The ACCESS also gained the sales amount data of non-prescription anti-diarrheal drug (*Loperamide*), which can reflect the incidence of mild diarrheal cases that are not required to see a doctor. • Construction work for the database of malaria incidence is progressing smoothly; whereas that of pneumonia and diarrhea is 6 – 12 months behind the schedule since it took longer-than-expected time for the South African side to allocate budget for the construction of the database, and to computerize a huge amount of paper-based information.
1-1-2. To determine investigation target sites on the basis of a risk map for respective diseases, which is developed using retrospective data from the database.	• The DOHL-Malaria, jointly with the NEKKEN, develop a malaria risk map using extracted data from the database. The Project chose the Greater Giyani as the target area for investigation on the basis of the risk map. • The Project, at the initiative of the MRC and the NEKKEN, is supposed to develop risk maps for pneumonia and diarrhea immediately after the construction of the database. • The Project chose the Greater Giyani as the target area for pneumonia and diarrhea research, the same area with that for malaria, in consideration of the efficient implementation of field activities when needed, given that the distribution of the incidences of pneumonia and diarrhea were equable in the Limpopo province.
1-1-3. To conduct fact-finding surveys at communities in the targeted sites with regard to incidence and prevalence of respective diseases (including undiagnosed diseases), residents' behavior that impacts on the	• The Project, at the initiative of the DOHL-Malaria, the MRC and the NEKKEN, commenced investigation of the prevalence of asymptomatic malaria infection by testing community residents (approx. 500 households in the Greater Giyani) with a LAMP-based rapid diagnostic test kit from the epidemic season of 2015/2016. • The Project investigated the implementation record of the Indoor Residual Spraying (IRS) in the same area.

prevalence (health seeking behavior, etc.) and hygienic environment (water quality, air pollution, malaria mosquito insecticide resistance etc.), followed by populating the data into the database.	• The Project placed light trap for malaria vector mosquito of anopheles in the 2015/2016 epidemic season; however, enough amount of anopheles was not captured to implement the experiments (e.g. insecticide resistance) due to the low mosquito density. • The Project also investigated residents' health seeking behavior that impacts on the epidemic of communicable diseases as well as hygienic environment and air pollution in the communities that can influence the incidences of diarrhea and pneumonia.
1-1-4. To source climatic and non-climatic ancillary environmental data (geographic data, etc.) from ACCESS partner organizations such as the South African Weather Service (SAWS) and the Agricultural Research Council (ARC).	• The JAMSTEC, with the support of the NEKKEN and the UL, gained satellite observation-based climatic data as well as non-climatic ancillary environmental data (e.g. geographic data) from the ACCESS partner organizations, and used them for improving the existing seasonal prediction system based on an ocean-atmosphere coupled general circulation model (SINTEX-F) (for the development of SINTEX-F2) and for the development of communicable diseases risk maps. • Meanwhile, it was supposed that the terrestrial climate data will be provided by the ARC and the SAWS to the Project; nevertheless, the said data was not provided by the ARC. However, though it took longer-than-expected time, a contract for the provision of the terrestrial data from the SAWS was eventually concluded in August 2016; the said data has just become available for the Project. However, the terrestrial climate data were supposed to be used for the verification of the skill of the downscaled climate prediction; thus, this delay in the signing of the contract has less influence on the development of SINTEX-F2. • The SAWS was regarded as an external supporting agency at the beginning of the Project, but was authorized as an official member of the Project at the time of the 2nd JCC held in October 2015.
1-1-5. To observe local-scale meteorological data in the target sites by placing basic observation stations at public buildings.	• The Project, at the initiative of the ACCESS the DOHL-Malaria and the NEEKEN, installed a total of 7 Automatic Weather Observation Systems at the cooperative health facilities in the Greater Giyani for the collection of terrestrial climate data. • The SAWS is covering whole land of the South Africa for the collection of terrestrial climate data, whereas the Project can obtain the said data in detail and immediately in the target areas.
1-2. Elucidation of relationships among incidence/prevalence of the target diseases and climate variability (ambient temperature, humidity, precipitation, etc.).	
1-2-1. To investigate the relationship between incidence/prevalence of the target diseases and climate variability using time-series analysis.	• The Project, at the initiative of the NEKKEN and JAMSTEC, revealed the significant correlation between the number of malaria patients and climate variation (temperature and precipitation amount) using several types of time-series as well as spatial statistical analyses on the data available since 1998. To be more precise, the analyses demonstrated the negative correlation of the number of the malaria patients with the precipitation amount in the southern part of Mozambique and Zimbabwe as well as the west wind, and the negative correlation with the sea surface temperature; in particular, the positive correlation with La Niña. The Project also performed the analyses on the seasonal variation in the said correlation. • The Project is supposed to start the investigation of the relationship between the climate variability and the incidence of pneumonia or diarrhea once the database become available. The Project, nevertheless, gained preliminary analysis results from the information of insurance claims with the diagnosis of pneumonia as well as diarrhea from an insurance company. Those suggest a correlative relationship between the climate variability and the said two communicable diseases to a certain extent though the condition of data collection is rather biased.
1-2-2. To investigate the relationships of proliferation of malaria vectors with climate variability and malaria incidence/prevalence.	• As was shown in the Activity 1-1-3, the Project unfortunately could not obtain enough amount of wild anopheles to analyze such as the relationship between vector mosquito and climate variability or malaria prevalence. Given that the Project can capture enough anopheles in the coming epidemic season of 2016/2017, correlation

	analyses are supposed to be performed immediately. ● However, the Project has commenced a research for the relationship between the ambient temperature and the development of anopheles using the artificial environment test system at the Tzaneen Malaria Institute (TMI) from 2015. The results of vector mosquito research are supposed to be used for fine-tuning of the mathematical models for the prediction of malaria incidence.
1-2-3. To investigate the relationship between regional-scale climate variations in the Limpopo Province and their links with the global climate phenomena such as the El Nino Southern Oscillation (ENSO), the Indian Ocean Dipole Mode (IODM) and the Sub-tropical Dipole Mode (SDM).	● The JAMSTEC, using SINTEF-F2, revealed that the climate in southern Africa including the Limpopo province is affected by ENSO as well as IOD and SDM. ● The JAMTEC also discovered the decadal change in the precipitation in southern Africa on top of inter-annual or seasonal variation from the analyses of meteorological observation data. Further, the analyses results using SINTEX-F2 demonstrated a strong correlative relationship between the said decadal change and other decadal change in sea surface temperature as well as pressure that moves e ● In this regard, the Project points out that the possibility of positive correlation between the decadal climate change in southern Africa and the malaria incidence in the Limpopo province, and is working on the detailed analyses on it as of the time of the Mid-term Review.
1-3. Development of infectious disease mathematical and/or statistical models for malaria, and statistical models for pneumonia and diarrhea of which local epidemic situation is reflected	
1-3-1. To review existing infectious disease models (related to climate in particular) for malaria, cholera, and pneumonia.	● There are several prediction models for the incidence of communicable diseases; to be more specific, statistical models that causally infer the relationship between past malaria incidence data and meteorological data, as well as mathematical model that infer the characteristics of various phenomena (malaria incidence in this case) by expressing it with mathematical formula. The Project, at the initiative of the NEKKEN and the JAMSTEC, reviewed existing infectious disease models for the prediction of the incidence of malaria, pneumonia and diarrhea. ● The review results showed that statistical models are mainly used for the prediction of the incidence of pneumonia and diarrhea. On the other hand, there are several mathematical models derived from the Ross–Macdonald Model for the prediction of malaria transmission. The VECTRI model is a brand-new model of the said mathematical model, which takes the ecology of vector mosquito into consideration. The Project made a contact with the developer of the VECTRI model and obtained the source code information from him.
1-3-2. To develop basic mathematical and/or statistical models for malaria, and statistical models for pneumonia and diarrhea by modifying existing model(s) or newly developing.	● The NEKKEN and the JAMSTEC developed several statistical models that take the climate (precipitation and ambient temperature) into consideration on the basis of time-series and spatial analysis of malaria incidence in the Limpopo province. Additionally, they developed a mathematical model for malaria transmission by adding meteorological factors to the said VECTRI model. ● In parallel with the above-mentioned research activities in Japan, the UWC is working on the development of mathematical models for malaria incidence prediction independently and published one research article in an international journal and another article is under peer review at the time of the Mid-term Review. ● The NEKKEN and the JAMTEC jointly held a model development seminar to discuss the skill of the malaria epidemic prediction models developed by the Japanese research institutes of the NEKKEN, the JAMSTEC and the Kyusyu University. For your information, a model developed on the bases of the Distributed Lag Non-linear Model by taking the secondary infection and precipitation into consideration (i.e. distributed lag non-linear model) demonstrated the best prediction skill of 78% predictive accuracy for the > 75% elevation of weekly malaria incidence with 3 to 4 weeks lead time. ● Meanwhile, the Project is supposed to commence the development work of prediction models for pneumonia and diarrhea immediately after the database become available.
1-3-3. To calibrate the models by	● The NEKKEN, the JAMSTEC and the UWC, in charge of the

verifying their prediction performance using retrospective and prospective data/information of infectious diseases obtained from the database.	development of prediction models for malaria incidence, are working on the verification and subsequent fine tuning of their own models using retrospective data at the time of the Mid-term Review. ● Prediction models for pneumonia and diarrhea incidences are also supposed to be verified and fine-tuned using retrospective data once the database is available and subsequently, trial models are developed.
1-4. Improvement of a seasonal prediction system based on an ocean-atmosphere coupled general circulation model (CGCM) called SINTEX-F; improving its skill, downscaling, extending its lead-time	
1-4-1. To improve the prediction accuracy of SINTEX-F for the short-term seasonal climate variability by enhancing model resolution, implementing better physics and data assimilation in next versions of SINTEX-F on the Earth Simulator.	● In 2015, the JAMSTEC had succeeded in developing a novel CGCM-based seasonal prediction system on the basis of the SINTEX-F (i.e. SINTEX-F2) with further enhanced resolution and by taking the influence of Antarctic sea ice. The SINTEX-F2 improved its prediction accuracy on SDM in southern Indian Ocean as well as precipitation in southern Africa in the austral summer season. ● The JAMSTEC completed the development of the SINTEX-F2; nevertheless, is supposed to continue fine tuning of it by intercomparing with other climate models for further improvement of prediction skill.
1-4-2. To reduce model biases by model validations and intercomparisons among SINTEX-F1, new SINTEX-F2 and other climate models developed in South Africa.	● The CSIR and the UP, in parallel with the JAMSTEC, are working on the development and fine tuning of their own seasonal climate prediction models as well as continuing information and technology exchanges with the JAMSTEC. ● The South Africa and Japanese sides have reached an agreement for the development of a multi-model ensemble prediction system by averaging out the models developed by both South Africa and Japanese research institutes.
1-4-3. To improve resolution and lead time for climate prediction of the SINTEX-F for better local-scale prediction performance by using a dynamical downscaling model such as Weather Research and Forecasting model (WRF) and statistical downscaling techniques.	● The JAMSTEC has succeeded in downscaling of global seasonal forecasting into local-scale prediction covering as narrow as approx. 10km^2. The JAMSTEC and the CSIR jointly investigated the performance of the dynamical downscaling model, and confirmed the significant improvement of prediction accuracy in ambient temperature and precipitation, which are susceptive of the complex topography in South Africa.
1-4-4. Interactively with the Activity 1-4-3, to fine-tune WRF downscaling model using local data available from the weather and climate observations at the target areas (Activity 1-1).	● Further, now that the terrestrial climate data of the SAWS become available, the Project is supposed to continue research activities for further improvement of prediction skill and lead time using the terrestrial data in addition to the satellite observation-based climate data after the time of the Mid-term Review.
1-5. Development of the climate-based infectious disease prediction models for malaria, pneumonia and diarrhea	
1-5-1. To develop a climate-based infectious disease epidemic prediction models for malaria, pneumonia and diarrhea by coupling the infectious disease mathematical and statistical models and the adopted climate prediction model, in light of the relationships among incidence/prevalence of the target diseases, climate variability and proliferation of vectors (Activity 1-2).	● The NEKKEN and the JAMSTEC has just commenced developing a "*climate-based malaria epidemic prediction model*" by coupling dynamically-downscaled climate prediction data with malaria epidemic prediction model(s) from the year of 2016. ● In July 2016, the NEKKEN and the JAMSTEC conducted a meeting in Nagasaki to confirm the progress and achievement of developing work of the climate-based infectious disease epidemic prediction modeling and discussed about the procedures and direction of the developing work of it. As of the time of the Mid-term Review, no significant research outcome had gained regarding the coupled model. ● Moreover, concrete consultation has not been commenced among South African and Japanese research institutes for coupling climate prediction models with infectious disease epidemic prediction models; in particular, the way of proceeding collaborative research, the method of coupling, etc. It is anticipated that the concrete discussions are commenced at the time of the Scientific Meeting held on the 29th of September 2016.
1-5-2. To calibrate the models by verifying their prediction	● The Project estimates that it will take a couple of months to link up the dynamically-downscaled climate prediction model to infectious

performance using existing data/information of infectious diseases epidemics and outbreaks obtained from the database.	disease epidemic prediction model. The Project is supposed to start with "*malaria*" for the target disease of the climate-based infectious disease epidemic prediction model. • All the research activities for the development of climate-based infectious disease epidemic prediction models targeting pneumonia and diarrhea will be commenced after the database become available.

Output 2

Operational guidelines of the climate prediction-based infectious diseases early warning system (iDEWS) are developed in the Limpopo Province.

Activities	Performances
2-1. To launch a preparatory committee for introducing the iDEWS at the Limpopo Province consisting of organizations responsible for epidemic prediction, issuing epidemic/alerting information and implementing countermeasures based on such information.	• The Project has commenced discussions among Japanese and South African research institutes in October 2015 for the establishment of a preparatory committee for introducing the climate prediction-based iDEWS. The Project held 2nd meeting in April 2016 to discuss the details of the committee and determined the Terms of References (TOR) of the Committee and nominated core members and external supporters. • The DOHL (officers in charge of the control of malaria, pneumonia and diarrhea), the DOH-Malaria, the TMI, and South African and Japanese researchers participating in the Project are nominated as core members of the iDEWS Preparatory Committee. Additionally, officers in charge of the control of malaria, pneumonia and diarrhea in the national DOH, representative(s) of the National Disaster Management Centre (NDMC), representatives from the Public Health Association of South Africa (PHASA) and a legal advisor are expected to be external advisors. Chairperson and co-chairperson are supposed to be determined at the 1st iDEWS preparatory committee meeting, though it is not scheduled yet as of the time of the Mid-term Review. • The Project envisages that the iDEWS is operated as a part of administrative systems (e.g. communicable diseases surveillance system, disaster management system, etc.) in the Limpopo province or even in the national level in future; thus, it is expected that the DOHL, a main user of the iDEWS, will take lead role of the development of iDEWS with guidance from the national DOH and the legal advisor.
2-2. To set criteria for outbreak alerting. 2-3. To set communication flow of infectious diseases epidemic/outbreak information in the Limpopo Province.	• Due to the transfer of a focal person in the Limpopo province and other managerial issues, the Project is still in the process of finalization of the committee members such as the DOHL, the national DOH and the NDMC as of the time of the Mid-term Review. Since the initially-scheduled day of the establishment of iDEWS preparatory committee was March 2016 and subsequent activity (i.e. setting of the criteria of outbreak alerting for each target disease) were supposed to get started from April 2016, it is deemed that the project activities lag behind schedule by 6 to 12 months as of the time of the Mid-term Review.
2-4. To develop an iDEWS operational Guidelines comprising regular reporting of epidemics, issuing outbreak alerting and consequent countermeasures, organogram of iDEWS operation, formats of regular reporting and alerting, etc.	• Once the member of the iDEWS preparatory committee members are fixed, the Project will convene the 1st meeting in the Limpopo province, and promptly move on to the development work of the iDEWS Operational Guidelines made up of the distribution methods of information of the infectious disease epidemic prediction including outbreak alerting, setting the condition of issuing information and/or outbreak alerting, etc. starting with a target disease of malaria. Developing work of the operational guidelines of iDEWS for pneumonia and diarrhea is expected to be conducted in parallel of that of climate prediction-based infectious disease epidemic prediction model.

Output 3 Prediction performance and operability of the iDEWS are verified.	
Activities	Performances
3-1. To evaluate the prediction performance and operability of the iDEWS through a pilot application at the Limpopo Province. 3-2. To conduct table-top exercises regarding issuing outbreak alerting and consequent countermeasures at the Limpopo Province. 3-3. To develop a sustainable monitoring and evaluation system for assessing impacts of the iDEWS on infection control at the Limpopo Province.	● Test operation of iDEWS (Activity 3-1), the implementation of table-top exercises (Activity 3-2) and the development of the monitoring and evaluation system (Activity 3-3) are supposed to be conducted in order after the operational guidelines are developed. ● These activities are expected to be started in parallel from April 2017.
3-4. To verify the applicability of other areas using available data of epidemics, climate and non-climate environment at other provinces of the South Africa and neighboring countries.	● After the prediction performance and operability of the iDEWS are verified through the above-mentioned activities, the Project is supposed to start concrete discussions among stakeholders with regard to the application of iDEWS to other provinces in South Africa and/or neighboring countries. ● This activity is supposed to be commenced from January 2018.
3-5. To hold workshop(s) geared to administrative officers, researchers, etc. in the areas of climate variability and infection control from the government of the South Africa and neighboring countries for the deployment of iDEWS.	● The Project held following symposia and workshops in South Africa or Japan as of the time of the Mid-term Review: – One-day Kick-off symposium in Pretoria geared to the project members (42 participants in total) in August 2014, hosted by the ACCESS; – One-day workshop in the Greater Giyani geared to DOHL, health professionals in the Limpopo province, and representatives from local community (32 participants in total) in October 2014, hosted by the DOHL-Malaria and the MRC; – One-day research symposium in Nagasaki, Japan geared to South African and Japanese project members and other stakeholders (50 participants including the South African ambassador to Japan) in January 2015, hosted by the NEKKEN; and – One-day research symposium in Pretoria geared to the project members and other stakeholders (32 participants in total) in October 2015, hosted by the ACCESS. ● On top of the symposia and workshops indicated above, the ACCESS and the UL jointly held three-day lecture series geared to master's students in South Africa in October 2015. ● The Project captured an opportunity of the visit of South African members to Japan for the symposium held on the 28th of January, 2015 to introduce the Project to ambassadors to Japan of the Southern African Development Community (SADC) member countries at regular meeting held on the next day (29th of January, 2016).
3-6. To start discussions with administrative officers, researchers, etc. in the areas of climate variability and infection control of the government of the South Africa for the dissemination of iDEWS.	● In parallel with concluding research outcomes and project activities, the Project is anticipated to start activities for the application of the iDEWS to other provinces. ● This activity is supposed to be commenced from January 2018.

2) Achievements of the Outputs

a) Output 1

Achievements of the Output 1 are as indicated below.

【Output 1】 Climate-based infectious disease epidemic prediction models are developed especially for malaria, pneumonia and diarrhea.	
OVIs	Achievements
1-1. The iDEWS for malaria is developed with the prediction performance that XX by the time of the Terminal Evaluation.	• The development work of malaria epidemic prediction models has generally been proceeding smoothly both in South African and Japanese research institutes. • Likewise, the development work of climate variability prediction models has also been proceeding smoothly both in South African and Japanese research institutes; further, succeeded in downscaling of global seasonal forecasting into local-scale prediction covering as narrow as approx. 10km^2 with maintaining its prediction performance. • It is estimated that the link-up of the climate prediction models and malaria epidemic prediction models as well as consequent development of iDEWS lag behind schedule by approx. 6 months as of the time of the Mid-term Review. However, since the project activities for the development of malaria iDEWS are anticipated to be completed by the end of the project period, it is deemed that the overall progress for the said purpose is fair to middling in general as of the time of the Mid-term Review.
1-2. The iDEWS for pneumonia is developed with the prediction performance that YY by the time of the Terminal Evaluation. 1-3. The iDEWS for diarrhea is developed with the prediction performance that ZZ by the time of the Terminal Evaluation.	• Meanwhile, the Project is subject to substantial delay in the construction database for inpatient data of the hospitals in the Limpopo province; consequently, the development work of the infectious disease epidemic prediction models for pneumonia and diarrhea has not been started as of the time of the Mid-term Review. • It is estimated that the project research activities for that purpose lag behind schedule by approx. 6 to 12 months as of the time of the Mid-term Review; nevertheless, the Project is expecting that the development work can be completed in shorter time than that used for malaria using its know-how and experiences. Further, the Project obtained a preliminary analyses results that suggests strong correlative relationship of the incidence of pneumonia and diarrhea with ambient temperature and precipitation, using the data provided by a health insurance company. • As was shown in the OVI 1-1, the development of climate prediction models are almost completed, the project research activities for the development of iDEWS for pneumonia and diarrhea are expected to be significantly accelerated to meet the due date of the Project.
1-4. More than 4 research papers first and/or co-authored by both Japan and South Africa collaborators related to iDEWS, infectious disease mathematical and statistical models, short-term climate variability prediction system, relationship between climate variability and infectious diseases are published in peer-reviewed internationally recognized journals.	• As of the time of the Mid-term Review, the Project already published as many as 14 research articles in total in peer-reviewed international journals; in particular, 3 articles for infectious disease epidemic prediction mathematic / statistical modeling, and 11 for seasonal climate prediction system. • On top of that, several research articles are just under review as of the time of the Mid-term Review. Since more research outcomes are anticipated to be generated as the project research activities move forward, more research articles will be published in international journals hereafter.

The JAMSTEC, with the support of the CSIR, had succeeded in developing a novel seasonal prediction system based on an ocean-atmosphere coupled general circulation model called SINTEX-F2 with higher resolution, which was developed on the basis of SINTEX-F by taking Antarctic sea ice into consideration. The SINTEX-F2 improved its prediction accuracy in southern

Africa significantly. Moreover, The JAMSTEC had succeeded in downscaling of global seasonal forecasting into local-scale prediction covering as narrow as approx. 10km^2. In parallel, the South African research institutes are working on the development and fine tuning of their own seasonal climate prediction models with the support of the Japanese research institutes. As of the time of the Mid-term Review, the Project has just commenced concrete discussions about how to link up the climate prediction information (incl. ensemble prediction) with infectious disease epidemic prediction models.

Meanwhile, concerning the development of infectious disease epidemic prediction models, that of malaria has been proceeding smoothly in general, whereas that for pneumonia and diarrhea has not been even commenced as of the time of the Mid-term Review, since the construction work of the database of hospital inpatient data was subject to significant delay. The Project, nevertheless, gained preliminary analysis results from the information of insurance claims with the diagnosis of pneumonia and diarrhea from an insurance company as well as the sales amount of OTC anti-diarrheal agent (*Loperamide*), which suggests a correlative relationship between the climate variability and the said two communicable diseases to a certain extent. Further, the Project obtained a preliminary analysis result that 1-degree C elevation of average ambient temperature in winter season might cause the elevation of diarrhea incidence by 20% from the data taken in the Western Cape province. Based on the said findings, the Project is supposed to accelerate their research activities for the development of infectious disease epidemic prediction models for all three target diseases until March 2017.

As was described in the OVI1-4, the Project has already published a total of 14 research articles with the theme of the development of infectious disease epidemic prediction modeling as well as climate variability prediction system in international journals. Hereafter, research findings or outcomes well further be gained through the development of infectious disease epidemic prediction models for pneumonia and diarrhea, operations research for the development of iDEWS and the ecology of malaria vector mosquito; thus, more research articles are anticipated to be published in scientific journals.

b) Output 2

Achievements of the Output 2 are as indicated below.

【Output 2】 Operational guidelines of the climate prediction-based infectious diseases early warning system (iDEWS) are developed in the Limpopo Province.	
OVIs	Achievements
2-1. The preparatory committee for iDEWS operation is launched at the Limpopo Province by the time of the Mid-term Review.	• The South African and Japanese research institutes had preliminary meetings twice for the establishment of the iDEWS preparatory committee as of the time of the Mid-term Review, and prepared a draft TOR of the committee and a list of envisaged members. • Due to the transfer of a focal person in the Limpopo province and other unexpected managerial issues, the Project is still at the final stage of the assignment of the committee members as of the time of the Mid-term Review. Once the members are fixed, the Project is supposed to convene 1st iDEWS preparatory committee meeting and assign the chairperson and co-chairperson.
2-2. The iDEWS operational guidelines is considered by authority/-ies concerned by October 2017.	• It is deemed the project activities, which are supposed to be led by the iDEWS preparatory committee, lag behind schedule by approx. 6 months. Concerning the development of climate-based infectious disease epidemic prediction models, especially that for pneumonia and diarrhea significantly lags behind schedule by approx. 6 to 12 months

	as of the time of the Mid-term Review. ● The Project is supposed to start the development of operational guidelines of iDEWS with malaria, immediately after the establish of the committee officially.

During 1st half of the project period, the Project has been putting efforts into the research-oriented activities by both South African and Japanese researchers for the establishment of basic technologies for the iDEWS. From the 2nd year of the project period, both South African and Japanese researchers have commenced preparations for the preparation committee of the iDEWS. However, due to the transfer of a focal person of the Limpopo province and other managerial issues, the Project is still at the finalization stage for the establishment of the iDEWS preparatory committee. Having said that, the Project has already drafted a TOR of the committee; thus, once the committee members are fixed, the Project, at the initiative of the iDEWS preparatory committee, is supposed to accelerate project activities for the development of operational guidelines of iDEWS. It is expected that the DOHL will lead the committee core members in the Limpopo province such as the DOHL-Malaria and the TMI, and the both South African and Japanese project research institutes will support them from the technical standpoint. Besides, in consideration that the iDEWS will be operated as a part of provincial or national administrative system(s) in future, the representative(s) from the national DOH and the NDMC as well as a legal advisor are also envisaged to be external advisors of the iDEWS preparatory committee.

On the other hand, the Project is supposed to shift them from research-oriented activities to practical application-oriented activities after the time of the Mid-term Review. Accordingly, the main players of the Project will also be shifted from researchers to the health-related officers in the Limpopo province such as the DOHL. Under such circumstances, it is required for the Project to strengthen the progress management hereafter.

c) Output 3

Achievements of the Output 3 are as indicated below.

[Output 3] Prediction performance and operability of the iDEWS are verified.	
OVIs	Achievements
3-1. Prediction performance and operability of the iDEWS are evaluated by a pilot application at the Limpopo Province by May 2018.	● Evaluation of prediction performance and operability of the iDEWS are supposed to be done after the development of its operational guidelines.
3-2. Adaptability of the iDEWS to other areas including other provinces and neighboring countries is presented to appropriate authorities by February 2019.	● Likewise, discussions with authorities concerned for the application of iDEWS will be commenced after the verification of its prediction performance and operability. ● However, the Project has just started discussions with the Ministry of Health as well as the Malaria Control Programme in the Republic of Mozambique with regard to the possibility of cooperation and collaboration in light of the improvement of prediction skill of the malaria epidemic prediction models and malaria control measures. The said Mozambicans are invited to the Scientific meeting of the Project as guest speakers held on the 29th of September 2016 (during the Mid-term Review).

As was described in the achievement of the Output 2, practical work for the development of iDEWS has not been commenced in the Limpopo province as of the time of the Mid-term Review; thus, the remaining project activities should be accelerated under the strict progress management of the

Project after the Mid-term Review.

Meanwhile, as was shown in the achievement of OVI 3-2 above, the Project started discussion with the authorities concerned of the Republic of Mozambique in light of future application of the iDEWS to neighboring countries. Besides, the Project, at the initiative of the MRC, started activities for the collection of retrospective malaria incidence data in the Mpumalanga province and the KwaZulu-Natal province; subsequently, is planning to test the prediction skill of the malaria epidemic prediction models developed using the data in the Limpopo province by comparing that in the said provinces by the end of the project period. Besides, the Project already obtained insurance claim information for the diagnosis of pneumonia and diarrhea in the Western Cape province and the Gauteng province, of which data also applicable for testing the applicability of the models.

3) Achievements of the Project Purpose

[Project Purpose] A climate-based early-warning system model for infectious diseases control is established as a precursor for further application across southern Africa.	
OVIs	Achievements
1. The iDEWS, the installation guide, the operational guidelines, operational costs, etc. are packaged as a precursor model for disseminating to other areas by the end of the project period.	• It is deemed that the whole project activities lag behind schedule by approx. 6 to 12 month as of the time of the Mid-term Review; therefore, it is difficult at this stage to estimate the concrete achievement of the packaging of the iDEWS and subsequent presentation of it to the authorities concerned of South Africa as a tool for infectious disease control by the end of the project period.
2. The iDEWS is presented to relevant South African authorities as a tool by the end of the project period.	

The Project has mainly been working on the establishment of technologies on the basis of the "*research*" activities during 1st half of the project period, whereas, it is supposed that the Project will shift their activities from the research activities to practical application of research outcomes to the society; i.e. the establishment of the climate-based iDEWS as practical model(s) through the development of the operational guidelines, the verification of prediction performance and the packaging of the iDEWS for distribution it to other provinces and even neighboring countries. In order to realize that, it is considered that strong leadership and ownership of the Project should be exercised by the Limpopo governmental organizations such as the DOHL. The Project, simultaneously, is desired that stricter progress management should be done to complete the development of iDEWS for all 3 target diseases by the end of the project period, since the project activities already lag behind schedule by approx. 6 months as of the time of the Mid-term Review.

Criteria for alerting, prediction-based administrative countermeasures taken by the provincial agencies such as the DOHL, and responsible organizations for practical operation of iDEWS will be determined on the basis of the type of diseases. Especially for pneumonia and diarrhea, countermeasure to be taken on the basis of the prediction of incidence and/or outbreak should be pathogen specific; therefore, it is desirable that an expert with sufficient expertise and experiences of infectious disease surveillance and response will be assigned to provide technical guidance for the development of criteria and countermeasures on the basis of the prediction information.

Meanwhile, since the Project is implemented under the framework of the JICA's technical cooperation, the Project is expected to achieve the capacity enhancement of human resource as well as the reinforcement of organizational function, simultaneously with the generation of research outcomes, which contribute to the infectious disease control in South Africa. Having said that, the

research capacity of the South African research institutes is rather high enough to implement international collaborative research under the equal partnership between South African and Japanese research institutes. The Project, even at the halfway point of the project period indeed, has already published a total of 14 research articles in international journals, and more research articles are anticipated to be published during the 2nd half and even after the project period. This is considered that the achievements of the Project meet the requirement of SATREPS (generation of research outcomes), and implies the enhancement of research capacity in both South African and Japanese research institutes indirectly. After the time of the Mid-term Review, it is anticipated that the execution capability of the Limpopo province will be improved for infectious disease control and/or disaster management on the basis of the research outcomes of the Project.

3.3 Implementation Process

1) Progress of Activities

As indicated previously, the joint research regarding the development of climate change prediction models has progressed smoothly and already 11 academic theses have been published in the international professional journals. However, despite the expectation of the acquisition of ground observation data from the automatic meteorological observation device that is owned by the ARC, which is considered as the external cooperation institution of South Africa, in reality, cooperation for data supply could not be obtained. Ground observation data does not hinder model development as it is used for verification of prediction skills of climate variability models. At the time of the Mid-term Review, ground meteorological observation data of all of South Africa is now available, not restricted within Limpopo as the data of the automatic observation device of the project that is installed in the Limpopo province and the data of the SAWS have become available.

Regarding the development of infectious disease epidemic prediction models, the development of malaria epidemic prediction models is generally progressing smoothly. However, due to the delay of the transition of hospital data into databases, the development of epidemic prediction statistical models for pneumonia and diarrhea have been delayed by around 6 months to one year. However, at the time of the Mid-term Review, the database construction work is nearly completed and as the estimation of the Project, the development of models for pneumonia and diarrhea is expected to be completed by around March 2017.

At the same time, the selection of the members of the preparatory committee for the iDEWS development is at the final confirmation stage at the time of the Mid-term Review due to the transfer of the Focal Person of the DOHL, causing a delay of around 6 months.

2) Project Management and communication among parties concerned

As a result of re-examination of the research institutes of the South African side that are required for actual joint research, the NICD, the SAWS, the University of Pretoria, and University of Venda were added to the list of institutes for implementation of the Project and the National Institute of Disaster Management Center of South Africa and the Kyushu University participated as external cooperative institutes. As the result, a total of 16 institutes participated for the implementation of the Project including the external cooperative institutes, comprising 13 institutes from South Africa and 3 institutes from Japan.

The Project has an overwhelmingly high number of participating institutes among the SATREPS projects in infectious disease fields, making communication adjustments difficult. However,

cooperation relationship is maintained within the climate research groups in particular as a result of the previous SATREPS projects and smooth communication is maintained within the infection disease research groups thorough communication adjustment management of a project coordinator (JICA expert) who is stationed in South Africa. Therefore, it is considered that proper project management has been implemented.

3) Ownership and autonomy

Research institutes of South Africa that participate in the Project have reached a certain level and are carrying out joint research as equal partners with the Japanese research institutes. However, the Japanese research institutes are superior regarding the development of short-term meteorological prediction models and infectious disease epidemic prediction models that use super computers and the research institutes of South Africa are highly aware of the technological development and technological enhancement through the Project. Each research institution is frequently providing technical advice and information through e-mail and telephone and implementing joint evaluation for research results effectively as well as direct discussions through conferences while carrying out their own research independently based on its specific theme. Therefore, the ownership and autonomy associated with the implementation of joint research are considered to be extremely high.

However, at the initial stage of the Project, there was some discord between the research institutes of South Africa and Japan regarding recognition of the contents, purposes, and procedure for implementing the research under the Project. As the project has progressed, the recognition of common goals was achieved and the survey of the Mid-term Review indicates that most of the problems have been resolved.

On the other hand, as described above, since the development of iDEWS based on the climate change are to be implemented positively after the Mid-term Review, strong demonstration of the ownership and the autonomy by the Government offices of Limpopo including the DOHL will be required. As described in activity 3-5, many research symposiums and workshops have been held in the Limpopo province with the support of the Project. The lecture series, implemented in the Limpopo province, also provided an opportunity for evaluating the research of the Project by the related institutes of Limpopo and with the confirmation of the high interest and expectations on the iDEWS development and introduction in the Limpopo province, the commitment to the Project by the Limpopo Governmental offices can also be expected.

CHAPTER 4 EVALUATION RESULTS

4.1 Relevance

The relevance of the Project has been highly maintained hitherto.

1) Consistencies of the Project Purpose with the South African Health Policies and the needs of target groups

In Southern African countries including South Africa, infectious diseases are still major threats and diarrhea and pneumonia are the top two causes of deaths of children younger than 5 years of age (21.4% and 16.2% respectively in 2007) in South Africa. Malaria is well controlled in comparison to other Southern African countries. However, the Northeast regions of South Africa sharing the borders with malaria endemic countries such as Mozambique and Zimbabwe including the Limpopo province, which is the target region of the Project, are especially exposed to malaria infection risks. Under such conditions, the national DOH of South Africa positioned the reinforcement of infectious disease countermeasures as the "primary medical service" of the national program in "strategic plan 2015-2020". It promotes the strengthening of the infectious disease surveillance system and strengthening preparedness and core response capacities for public health emergencies in line with the International Health Regulations (IHR). The Government of South Africa stresses the implementation of the science and technology cooperation with Japan. The "*South Africa-Japan Cooperation in Science and Technology*" that was jointly announced by the DST of South Africa and the Japanese Embassy in South Africa stipulates the importance of JICA in the science and technology cooperation in South Africa and the role of SATREP and also provides the introduction of the Project.

Based on the above, the purpose of the Project that implements infectious disease countermeasures based on the technical enhancement of South African – Japan research institutes through the Project is consistent with the South African health policies, science and technology policies, and the needs from community residents in South Africa are highly maintained.

2) Consistency of the Project Purpose with Japan's Aid Policy

In the ODA policy in Japan also, infectious disease countermeasures are stressed and the "*Yokohama Action Plan 2013-2017*" that is the basis of the specific policy of the "*Yokohama Declaration 2013*" that was agreed in the 5th Tokyo International Conference on African Development (TICAD V) in June 2013 reviewed the importance of infectious diseases countermeasures and also indicates the importance of the approach towards climate change issues by many sectors. The "*Nairobi Declaration*" that was adopted in TICAD VI that was implemented in August 2016 confirmed that the "*Yokohama Declaration*" and "*Yokohama Action Plan*" are effective until the next TICAD in 2019.

In "*improvement of the standard of science and technology of Africa through human resource development*" and "*return of the results of research and development to the society*" in the proposal "*Rich Africa with the power of science and technology and innovation*" that was created by the science and technology adviser of the Minister for Foreign Affairs towards TICAD VI exactly match the idea of SATREPS. In this way, the Project matches the science and technology diplomatic strategy.

Therefore, there are high consistencies between the Project that aims at the establishment of the infectious disease early warning system based on the climate change prediction, the international

health policies and the science and technology diplomatic strategy of Japan.

3) International requirements relating to the infectious disease countermeasures based on the climate change prediction

WHO clarifies the necessity for the countermeasures for the impact of climate change such as global warming on the health of people. In particular, "*WHO Global Programme on Climate Change & Health*" (2016) indicates the importance of obtaining the scientific basis relating to climate change and health. Therefore, the development of infectious disease epidemic prediction models based on the correlation between climate change and malaria, pneumonia, and diarrhea and scientific analysis relating to the administrative handling based on the prediction information are also considered to meet such international demands.

Infectious disease prediction models based on climate and weather have been developed by many experts academically. However, there are hardly any examples of using the prediction information in the actual administrative systems. Establishment of infectious disease countermeasures and disaster countermeasures based on the highly accurate localized infectious disease epidemic prediction model within a period of several months would be the first example globally.

4) Appropriateness of implementation method

① Rational for the development of iDEWS targeting "*Pneumonia*" and "*Diarrhea*", both of which are not definitive diagnoses

"*Pneumonia*" is a disease presentation of inflammatory diseases in lung, of which cause can be an infection of pathogenic agents or be nonpathogenic reasons such as drug-induced pneumonia. Likewise, "*diarrhea*" can be infectious or non-infectious. Pathogens include viruses, bacteria, fungi, etc. and each of which has various species, and naturally, preventive measures and treatment varies in accordance with causative agents. In other words, the cause of pneumonia as well as diarrhea can be of great variety, and various factors can affect its onset. Besides, it is unlikely for diarrheal diseases except for cholera to cause outbreak at disaster level, and incidence of pneumonia or diarrhea can be managed within the range of seasonal change usually. Under such conditions, the Review Team and other relevant persons pointed out several questions as follows: whether how much a limited factor of the climate prediction information affect the incidence of pneumonia as well as diarrhea; and whether it is necessary for the development of a system to determine administrative countermeasures based on the climate-based infectious diseases epidemic prediction results for pneumonia and diarrhea which can be managed within the normal range of seasonal change.

Responding to the abovementioned questions, the Project explained the necessity for the development of iDEWS for pneumonia as well as diarrhea because they have obtained a preliminary analysis result explaining the correlative relationship between the climate (ambient temperature and precipitation) and the incidence of pneumonia or diarrhea; besides, other preliminary analyses suggest that the 1-degree C elevation of ambient temperature might cause an elevation of diarrhea incidence by 20% in winter season. On the other hand, especially in the rural part of South Africa, it is usually difficult to obtain the information of definitive diagnoses, i.e., causative pathogens, but the name of disease group of "*pneumonia*" and "*diarrhea*". The Project, nonetheless, observed a certain causative relationship of the climate variability with the said disease groups of pneumonia and diarrhea under the real situation in South Africa that the number of cases and even casualties of pneumonia and diarrhea are significantly greater than that of

malaria. Moreover, it is of great needs for the DOHL, other administrative bodies and health facilities in the Limpopo province to receive prediction information of the incidence of pneumonia and diarrhea in advance of occurrence. Therefore, both the Review Team and the Project confirmed the rationale for the development of iDEWS for pneumonia as well as diarrhea within the framework of the Project.

Having said that, it is still true that the prevention measures and treatment should be determined in accordance with the causative pathogens; therefore, the Project, at the initiative of the iDEWS preparatory committee, should carefully determine the definition of the name of disease group of "*pneumonia*" and "*diarrhea*" and how the countermeasures will be taken on the basis of the infectious disease prediction information under the Output 2, on the basis of the available evidences as well as the support of expert(s) in that technical field.

② Special consideration for gender issues, social grades, environment, ethnic groups, etc.

Since the Project does not involve direct handling of infectious substances as a part of the development of the warning system based on the epidemic prediction of malaria, diarrhea, and pneumonia, no special consideration is required for the environment and health threats to the experts (researchers).

The technical capability of the research institutes of South Africa is comparatively high, however, the opportunities for the students of regional universities to experience cutting-edge research are restricted. In the Project, a lecture series targeting the students of the master's degree course was held and Limpopo was determined as the venue to enable the students of the UL and the UV, which is located near the border with Zimbabwe to participate in the lectures.

4.2 Effectiveness

The effectiveness of the Project is considered to be high in general at the time of the Mid-term Review.

1) Probability of Achievement of Project Purpose

As was described in the Achievement of the Project Purpose section, the Project has been working on the development of basic technologies for the establishment of iDEWS on the basis of the development of climate variability prediction models and infectious disease epidemic prediction models for the 1st half of the project period.

It is notable that the Project succeeded in developing a novel seasonal prediction system based on an ocean-atmosphere coupled general circulation model called SINTEX-F2, which was developed on the basis of SINTEX-F by taking Antarctic sea ice into consideration and better resolution. The development of SINTEX-F2 is deemed to be a breakthrough in the field of the climate variability prediction modeling. The South African research institutes are also working on the development of climate variability prediction models with the direct or indirect support of the Japanese research institutes. The Project has published as high as 11 research articles in the climate research field even at the halfway point of the project period indeed.

On the other hand, concerning the development of infectious disease epidemic prediction models, that of malaria has been proceeding smoothly in general, whereas that for pneumonia and diarrhea has not been even commenced as of the time of the Mid-term Review, since the construction work of the database of hospital inpatient data was subject to significant delay. However, the Project has

published a total of 3 research articles regarding malaria epidemic prediction modeling in international journals. The Project estimated that the epidemic prediction modeling for pneumonia and diarrhea well be completed in a relatively short period of time using experience and know-how of that for malaria.

After the time of the Mid-term Review, the Project is supposed to move on to the research activities to link up the climate prediction models with infectious disease epidemic prediction models with securing sufficient prediction performance and lead time (a couple of months at least). Thus, it is anticipated that more research articles regarding climate-based infectious disease epidemic prediction modeling will be published hereafter. Looking at that from another perspective, a number of research articles published in peer-reviewed international journals might indirectly explain the enhancement of the capacity of research institutes as well as researchers in both South Africa and Japan.

For these reasons, since the Project achieved a lot of scientific research outcomes as well as the enhancement of the capacity of research institutes and researchers, the effectiveness of the Project as of the time of the Mid-term Review is deemed to be significantly high from the academic point of view.

Having said that, the goal of this project is to develop a climate-based iDEWS model for evidence-based infectious disease control; therefore, the success of "*practical application of research outcomes to society*" of which activities will fully be implemented after the time of the Mid-term Review is essential to secure the effectiveness of the whole project. Further, since the project activities is lagging behind schedule by approx. 6 months as of the time of the Mid-term Review, stricter progress management is required for the Project to complete all the planned activities by the end of the project period. Especially for the iDEWS for pneumonia and diarrhea, it is desirable, as was described in the Relevance section' that the development of operational guidelines is implemented on the basis of currently-available evidences under the guidance of expert(s) with sufficient knowledge and experiences in that field.

2) Important assumptions for the achievement of Outputs and Project Purpose

Current status of the important assumption of "*Necessary cooperation is gained by external project supporters (e.g. the National Department of Health, SAWS, ARC and superintendents of public buildings, etc.) for the project activities*" for the achievement of Outputs

As was described in the Activity 1-1-4, it was supposed that the terrestrial climate data will be provided by the ARC and the SAWS to the Project; nevertheless, the said data was not provided by the ARC. However, though it took longer-than-expected time, a contract for the provision of the terrestrial data from the SAWS was eventually concluded in August 2016; the said data has just become available for the Project. However, the terrestrial climate data were supposed to be used for the verification of the skill of the downscaled climate prediction; thus, this delay of the signing of the contract has less influence on the development of SINTEX-F2.

The SAWS was placed as an external supporter at the initial phase of the Project, but become the project member at the time of the 2nd JCC held in October 2015.

3) Contributing Factors for Effectiveness

Many institutes including the implementation institutes (14 institutes in total) participated in the Project. Frequent communications and discussions were held via e-mail and telephone within both

the research groups that are engaged in the development of climate change prediction models and the groups that are engaged in the development of infectious disease epidemic prediction models. These are the factors for achieving smooth implementation of joint research in remote mode between South Africa and Japan and for acquiring the research results as described above.

4) Inhibitory Factors against Effectiveness

It was agreed that the computerization of paper-based inpatient hospital information followed by the construction of database would be done by the input from the South African side. The said works require a lot of labor force; thus, it was required for the South African side to allocate some budget to outsource. Unfortunately, the budget took longer-than-expected time to become available of the budget on the South African side.

Since this caused a certain delay in the project activities especially for the development of infectious disease epidemic prediction modeling for pneumonia and diarrhea, this can be recognized as a hindering factor to the effectiveness of the Project.

5) Others

After the commencement of the Project, the project members of the national DOH, the DOHL, and the CSIR left the project due to the job transfers. To maintain the collaborative relationship with the new members, some efforts and time were required from the Japanese project members. Although there were some replacements of the junior researchers of South Africa who have participated in the research activities of the project, the negative impact on the project activities was avoided by the effort of the project members.

Meanwhile, the density of malaria vector mosquito is rather low in South Africa; on top of that, the amount of wild mosquito captured by the Project is substantially lowered due to the effect of El Niño. Therefore, research on the ecology as well as insecticide resistance has not sufficiently been done as of the time of the Mid-term Review. However, no critical effect of this situation on the development of malaria epidemic models since such information is not necessarily used for modeling. Having said that, once the Project progresses research on malaria vector mosquito, it is anticipated that research findings and outcomes will be utilized for fine tuning the models.

4.3 Efficiency

The efficiency of the Project is moderate since unexpected external factors caused delays in several research activities as of the time of the Mid-term Review.

1) Progress Management of the Project Activities

The MOU was exchanged between the South African side and the Japanese side in May 2014; nevertheless, two (2) long-term JICA experts (a researcher and a project coordinator) arrived at their positions in South Africa in October 2014, five (5) months after the commencement of the Project, which resulted in delays in the installation of research instruments as well as the commencement of data collection activities. Aside from this, it took longer-than-expected time for the South African project member organizations to enter into the MOU among them, which resulted in some delay in the acquisition of the terrestrial climate data.

As has been described the budget allocated by the South African side for the construction of the

database of hospital inpatient information became available eventually in 2016; for this reason, epidemic prediction modeling for pneumonia and diarrhea has not been commenced as of the time of the Mid-term Review, and it is estimated that this activity is lagging behind schedule by approx. 6 – 12 months. Apart from this, the Project is still working on the establishment of the iDEWS preparatory committee by finalizing the members due to the transfer of a focal person in the Limpopo province, which also resulted in the delay by approx. 6 months.

Having said that, the South African and Japanese research institutes have continuously and frequently been communication each other through various channels such as two (2) JCC meetings, symposia held both in South Africa and Japan, day-to-day emailing and teleconferences as of the time of the Mid-term Review; for these reason, it is deemed that the management of the progress as well as the generation of research outcomes has generally been appropriate. This can be explained by the significant achievement of research outcomes of the Project even at the halfway point of the project period. Further, the causes of the delays are seemed to be external factors, and the South African side has been putting best effort to the Project by allocating their own budget for the project activities as well as working on the orchestrating the iDEWS preparatory committee. Therefore, it is considered that the project management itself was appropriate in general.

Having said that, the Project is required to accelerate their research activities for the development of epidemic prediction models for pneumonia and diarrhea. The Project is supposed to move on to the research activities for linking up of the climate prediction models to the infectious disease epidemic models, followed by the verification of prediction performance as well as its lead time. The Project, in parallel with those research activities, will shift their focus to the practical application of research outcomes to society in the Limpopo province (i.e., the development of iDEWS operational guidelines and subsequent verification of its operability). Accordingly, the administrative organizations in the Limpopo province such as the DOHL are supposed to take leading role for the activities for the said application work in tandem with the South African and the Japanese research institutes. Meanwhile, it is anticipated that the iDEWS will be operated as a part of infectious disease surveillance system and/or disaster management system in the Limpopo province and/or at national level; therefore, the Project is required to follow legal and ethical standards in South Africa for the project activities aiming at the application of the iDEWS for the said systems. For these reasons, it is strongly required for the Project to strengthen the management of the progress and the generation of outcomes further after the time of the Mid-term Review.

2) Beneficial utilization of provided equipment and materials

The Project has been conducting research activities by utilizing existing research instruments in South Africa, but provided a minimum of instrument, equipment and devices to the South African member organizations. The installation of research instruments was almost completed as scheduled as of the time of the Mid-term Review.

Though the frequency of use varies in accordance with the related purpose and environment, all the instruments, equipment and devices are properly used to the research activities and maintained by the South African side.

3) Beneficial utilization of knowledge and skills acquired at the training in Japan

A total of three (3) South African young researchers were dispatched to Japan for short-term training. The knowledge and skills gained through the trainings are expected to be utilized to research activities such as data collection and analyses after the time of the Mid-term Review.

It is planned that several South African young researchers are dispatched to Japanese research institutes for training even after the time of the mid-term Review. In particular, a young researcher (meteorologist) is supposed to acquire technologies regarding global ocean modeling at the JAMSTEC, and expected to share what he learnt to other researchers in South Africa. Other researcher from the infectious disease research group is supposed to perform fine tuning of their infectious disease epidemic prediction model by comparing that developed by the Japanese research institute.

4) Collaboration with External Resources

① 開発 Collaborative development of latest malaria epidemic prediction model (VECTRI model)

The developer of the VECTRI model (an Italian researcher) provided its source code to the Japanese research institute, and they are collaboratively working on the improvement of the said model. The model is taking the ecology of malaria vector mosquito into consideration; thus, it is regarded as one of the most potential models of the project for malaria epidemic prediction as of the time of the Mid-term Review.

② Collaboration with the local NGO for the improvement of malaria surveillance system in the Limpopo province

For the effective operation of iDEWS as well as the performance verification of malaria epidemic prediction models, it is critical that malaria surveillance system is properly functioned, which provides original data and information to the prediction model. The Project was considering to introduce an infectious diseases reporting system using cell phone, which was well established by other SATREPS project in Kenya (the NEKKEN is an implementer of the project), and invited a researcher from the Kenya SATREPS project to the symposium held in the Limpopo province to give some lecture regarding the reporting system.

However, the Project abandoned their attempt to introduce the said system in the Limpopo province to avoid duplication since a local NGO supported by the Clinton Foundation HIV/AIDS Initiative after the symposium. The Project and the NGO agreed to support each other for the improvement of malaria reporting system in the Limpopo province. In particular, after the operation the reporting system which was supported by the NGO, the malaria incidence information was shared with the TMI within 24 hours after diagnosis; owing to this, the TMI can start the active surveillance for asymptomatic malaria infection promptly.

③ Development of automatic malaria diagnosis device

With the financial support of the Global Health Innovative Technology Fund, GHIT Fund, the National Institute of Advanced Industrial Science and Technology, the Panasonic Cooperation and the NEKKEN have been working together for the development a novel automatic malaria diagnosis device, and reached at the final stage of the development as of the time of the Mid-term Review. The Project is considering introducing the device to the research activities in the Limpopo province on a trial basis.

The device with high sensitivity and specificity is easier to operate than existing rapid diagnosis test kit and runs on an electric battery and solar energy. The device was introduced at the TICAD VI held in Kenya in August 2016 and came under the spotlight.

5) Contributing Factors for Efficiency

As aforementioned, 12 South African research institutes are participating in the Project and are widely scattered in whole of South Africa such as Pretoria, Limpopo, Durban and Cape Town.

Under such situation, the JICA expert (project Coordinator) stationed in South Africa performing strict liaison and coordination not only between South African and Japanese research institutes but also even among South African research institutes, and enjoys the confidence of both South African and Japanese researchers. This is regarded as a contributing factor for the effectiveness of the Project from the aspect of the smooth implementation of the project activities.

6) Hindering Factors against Efficiency

A South African research institute could not do assigned project research fully due to various reason, whereas they provided great help for the capacity building geared to students in South Africa. However, the JICA expert stationed in South Africa strongly support the activity and owing to that, critical effect on the progress of the Project was avoided.

This can be recognized as a hindering factor since necessary input from the South African side has not been fully exercised.

4.4 Impact

The following positive impacts are confirmed and/or expected by the implementation of the Project.

1) Probability of achievement of envisaged Overall Goal(s)

The technical cooperation projects, implemented under the scheme of SATREPS, are not always required to set Overall Goal(s) due to its characteristic feature of "*joint research project*". Having said that, SATREPS Project puts greater emphasis on the practical utilization of research outcome of projects to society; therefore, the Project clearly describes the expression of "*as a precursor for further application across southern Africa*", and the climate-based iDEWS model(s) for better control of infectious diseases in southern Africa are expected to be applied by their self-help endeavor after the end of the project period.

Since many malaria cases are reported in bordering areas with Mozambique and Zimbabwe, the Project selected the Limpopo province as the project site. The Project found that the incidence of malaria in the Limpopo province has a positive correlation with the precipitation in the southern part of Mozambique and Zimbabwe with 3-month time lag. Further, it is suggested that a definite proportion of malaria cases reported in the Limpopo province is imported cases from neighboring countries; therefore, it is desirable that the information of malaria incidence in those countries are provided to further improve the prediction skill of malaria epidemic prediction models. The Project has already started discussions with the Ministry of Health and the Malaria Control Programme in Mozambique as of the time of the Mid-term Review. Given that the support from the Mozambique are gained for the project research activities, the possibility of the future application of iDEWS in Mozambique where there are much higher number of malaria cases will increase.

However, in order to realize the application of the iDEWS to other provinces in South Africa and even other countries, the Project is required to prove that the iDEWS is functioned properly as a part of administration system, and also, to complete packaging iDEWS operational guidelines, resource

analyses (e.g. human resource, operational costs and timeframe) and other necessary elements for the application of iDEWS by the end of the project period. Further, the whole project activities seemed to lag behind schedule by approx. 6 months. For these reasons, the Project should accelerate the project activities after the time of the Mid-term Review under the strict management of progress and achievements.

2) Other Positive Impacts

① Relationship between the decadal change in the precipitation in southern Africa and the malaria incidence

As was shown in the Activity 1-2-3, the JAMTEC discovered the decadal change in the precipitation in southern Africa on top of annual or seasonal change from the analyses of meteorological observation data. Further, the analyses results using SINTEX-F2 demonstrated a strong correlative relationship between the said decadal change and other decadal change in sea surface temperature as well as pressure that moves eastward from the South Pacific Ocean to the South Indian Ocean.

Based on the said findings, the Project is working on the analyses using detailed retrospective data to investigate correlative relationship of the decadal climate change in southern Africa with the malaria incidence in South Africa as of the time of the Mid-term Review. If the Project succeeds in the relationship, the climate-based infectious disease epidemic prediction modeling as well as the practical administrative countermeasures are positively impacted by the evidence.

② Utilization of the database of hospital inpatients information for other researches

In South Africa, especially for rural area, no sophisticated database of hospital inpatients information is available by computerizing medical charts information. The Project, at the initiative of the MRC, spent a lot of time, costs and efforts to construct the database. It took longer-than-expected time to construct the database; nonetheless, it is recognized as a high value-added product of the Project because various information can be extracted from the database for retrospective medical researches regardless of infectious or noninfectious diseases.

Actually, a master student who has been assisting the project research activities is interested in using the database for his master's thesis of cardio-vascular diseases.

③ Functional enhancement of the Tzaneen Malaria Institute

A JICA long-term expert (epidemiologist / medical entomologist), stationed in the Tzaneen Malaria Institute, has been working together with the staff member of the TMI on their daily duties as well as project research activities, resulting in the capacity enhancement of the institute as well as staff members through the installation of research instruments and related equipment with necessary research techniques.

In particular, the TMI, with the support of the Project, established a surveillance system of imaginal malaria vector mosquito in the Greater Giyani as a sentinel site. Though the capturing of mosquito and the maintenance of light traps are conducted by temporally-hired community residents, it is anticipated that the system is maintained by the TMI even after the end of the project period. Meanwhile, the surveillance of larval mosquito has been done by the TMI as its duty. The TMI staff members, with the support of the JICA expert (researcher),

improved the implementation methods and developed or revised forms and norms such as an implementation manual, record forms and the Standard Operating Procedure(s) (SOPs). Furthermore, the JICA experts also assisted the TMI staff members to develop or revise the SOP and forms for the malaria active surveillance on human asymptomatic infection by investing residents of seven (7) households encompassing that of index cases. This surveillance system is well-established in the Greater Giyani (the project target site) and the TMI is planning to apply that to other area in future.

3) Negative Impact

No negative impact attributed to the implementation of the Project was observed as of the time of the Mid-term Review.

4.5 Sustainability

A self-sustainability as well as a self-deployment of the benefits provided by the Project can be expected to some extent as of the time of the Mid-term Review.

1) Political and Institutional Aspects

As mentioned in the Section of "Relevance", the political importance of the implementation of the infectious disease countermeasures based on the results of the relevant research (based on the reason) while enhancing the technological capability of the development of climate change prediction models and infectious disease prediction models in South Africa is expected to be strongly maintained up to and also beyond the end of the project. The political sustainability of the Project is expected to some extent at the time of the Mid-term Review.

As described above, the Project aims at the establishment of iDEWS towards malaria, pneumonia, and diarrhea as the infectious disease countermeasures based on the reasons. In addition, since the project includes the future deployment of the iDEWS in other provinces and neighboring countries in its activity viewpoints, it is necessary to prove, by the end of the project term, that the iDEWS functions as a part of the infectious disease surveillance system and the disaster countermeasure mechanism in Limpopo.

Therefore, the activities of the Project must be carried out carefully towards institutionalization of iDEWS while obtaining advice from the state organizations and legal advisers such as the DOH and National Disaster Management Center, keeping in mind that the iDEWS is to be operated as a part of the Administrative system.

2) Financial Aspects

Including the cases in Japan, in general, project search activities cannot be financed by the specific research budget of the organization only and continuous efforts are necessary to obtain support from external organizations such as competitive research funds. Therefore, it is difficult to evaluate the financial sustainability for the continuation of research at the time of the Mid-term Review.

On the other hand, as mentioned above, given that the iDEWS is included as a part of the infectious disease surveillance system or the disaster countermeasure mechanism, the budget for the continuous operation is expected to be secured as an Administrative system. Since future adaptation of the iDEWS in other provinces and neighboring countries of South Africa is considered in the Project and

packaging including the operation cost analysis is conducted as a part of the project activities, the information required for the budget plan for continuous operation is expected to be provided by the Project.

3) Technical Aspects

The Project is supposed to link up the climate prediction models to the infectious disease epidemic prediction models right after the time of the Mid-term Review, for the development of the climate-based-infectious disease epidemic prediction model(s). Both South African and Japanese research groups developed several prediction models for both climate and infectious disease incidence semi-independently as of the time of the Mid-term Review; hereafter, the Project is supposed to start detailed discussions on the concrete methods and procedures for coupling the said two types of models (e.g. *what kind of dataset should be prepared for coupling?*; *whether the models are selected in accordance with the purpose and/or condition?*; and *ensemble prediction will be done for all the time?*) among South African and Japanese research institutes. However, if the iDEWS preparatory committee decides to use multiple models of climate prediction and/or infectious disease epidemic prediction for providing prediction results to the iDEWS, it is necessary for the Project to hand over all the models to South African research institutes and they are required to maintain and/or adjusting them on the basis of prospective data for both climate and the incidence of infectious diseases. Therefore, the Project should start discussions among project members on the maintenance of the iDEWS, especially for the way of maintaining models (e.g. multiple models are maintained by the South African members? or the Project will try to develop a unified or simplified model(s) with maintaining minimum requirements of prediction performance?) right after the time of the Mid-term Review.

On the other hand, the technical sustainability of iDEWS can be secured if it is operated as a part of administration system at provincial and/or national level. For the sake of that, the Project is required to develop operational guideline of iDEWS with high feasibility, which meet the function and responsibilities of administrative organizations as well as the environment of health services in the Limpopo province.

4.6 Conclusion

As of the time of Mid-Term Review, the Project has produced many research outcomes which lead to the establishment of the iDEWS. The iDEWS is expected to contribute for the infectious disease control of malaria, diarrhea, and pneumonia.

The Project can be highly evaluated in terms of relevance and effectiveness. For the relevance, there are high consistencies with both South African and Japanese policies on the science and technology as well as the policy of national DOD to strengthen the infectious disease surveillance system and strengthening preparedness and core response capacities for public health emergencies in line with International Health Regulations (IHR). For the effectiveness of the Project, the development of prediction models for malaria incidence is on the process of the verification. Inpatient data has been registered into database through the efforts of the members and will be ready to analysis with climate factors.

The efficiency of the Project is moderate owing to the unexpected external factors, which caused delays in several research activities but those are managed through efforts of the project team as of the time of the Mid-term Review. The sustainability is expected to be high since the Project provides

the sustainability as well as a border deployment. In addition to the scientific achievements, the Project has achieved significant human resource development, especially for young researchers and students in both South Africa and Japan.

The South Africa – Japan collaborative research has produced several important findings obtained through the newly developed SINTEX-F2 seasonal climates prediction system and analysis of real climates observation as follows: 1) decadal change in the rainfall (precipitation) in the area of southern Africa on top of the annual or seasonal change; 2) a strong correlative relationship between the said decadal change of rainfall and other decadal change in sea surface temperature as well as pressure that moves eastward from the South Atlantic Ocean to the South Indian Ocean; 3) in this regard, the Project points out that the possibility of positive correlation between the decadal climate change in southern Africa and the malaria incidence in the Limpopo province with 3-month time lag; and 4) preliminary analyses that climate drives diarrhea show potential successful application of iDEWS.

CHAPTER 5 RECOMMENDATIONS

The Team made the following recommendations based on the result of Mid-term Review.

(1) Development of iDEWS

- After the time of the Mid-term Review, the Project will focus on the activities for the practical application of the research outcomes to society (i.e., the establishment of the climate-based iDEWS as a practical model in the Limpopo province). It is envisaged that the iDEWS is operated as a part of the administrative system such as infectious disease surveillance system and/or disaster management system in the Limpopo province and/or the national level; therefore, the Project should develop a proper collaborative relationship among iDEWS preparatory committee members such as the DOHL, the DOHL-Malaria, the TMI and South African and Japanese research institutes, with the support of the external advisors such as the national DOH, the NDMC and the legal advisor.
- The Project should perform resource analyses (human resource, necessary materials, costs and timeframe) for the operation of iDEWS based on the test operation in the Limpopo province when the Project develop an iDEWS package for the application to other provinces in South Africa and neighboring countries.
- The setting of alerting criteria, the administrative countermeasures based on the prediction information, and the responsible organization for the operation of iDEWS can be different in accordance with diseases. Likewise, it is envisaged that the way of prevention and control as well as treatment can vary in accordance with causative pathogens. Therefore, the Project should consider additional input of expert(s) with sufficient knowledge and experiences of infectious disease surveillance and response for the development of the operational guidelines of iDEWS.

(2) Development iDEWS for pneumonia and diarrhea

- Since the development of iDEWS for pneumonia and diarrhea is lagging behind schedule by approx. 6 to 12 months as of the time of the Mid-term Review due to the delay in developing database of hospital inpatient information, the Project should strengthen the progress management to complete the establishment of iDEWS for all 3 target diseases by the end of the project period.
- Pneumonia as well as diarrhea has a correlative relationship with climate. Besides, the incidence and casualty of pneumonia as well as diarrhea are overwhelmingly higher than that of malaria in South Africa. Therefore, the rationale of the development of iDEWS for pneumonia and diarrhea is secured. Having said that, since the prevention measures as well as treatment will be different in accordance with the type of diseases and/or causative pathogens, project members should reach a common understanding of the definition of "*pneumonia*" as well as "*diarrhea*". Further, the Project, at the initiative of the iDEWS preparatory committee, should carefully discuss evidence-based concrete countermeasures in accordance with the prediction information with the support of specialist(s) in consideration of the context in the Limpopo province.

(3) Securement of sustainability

- The Project developed several models for each "*climate prediction model*" as well as

"*infectious disease epidemic prediction model*" for linking them up to develop a "*climate-based infectious disease epidemic prediction model*". Some of the said models are supposed to be handed over to the South African research institutes; thereafter, maintained and even fine-tuned by themselves. In order for the iDEWS to be utilized continuously in South Africa, the Project should start discussions among relevant organizations on the maintenance of iDEWS; simplification or unification of the models can be one option.

- The Project should continue the capacity building of South African researchers through the collaborative research. In parallel, the Project is expected to raise capacity of project members in the Limpopo province for the reinforcement of infectious disease surveillance system through the project activities for the development of iDEWS after the time of the Mid-term Review. The accuracy improvement of the information from the infectious disease surveillance will also contribute to the improvement of the performance of infectious disease epidemic prediction models.

(4) Verification of applicability of the climate-based infectious disease epidemic prediction models in light of the application to other provinces and neighboring countries

- The Project intends to apply the iDEWS not only to other provinces in South Africa but also southern African countries in future. The Project has already commenced discussions with the authorities concerned in Mozambique, sharing the border with the Limpopo province; however, the Project should verify the applicability of iDEWS to other provinces and/or neighboring countries using currently-available data.

END

Project Design Matrix (PDM) version 1

Date: August 6, 2014

Project Title: The Project for Establishment of an Early-Warning System for Infectious Diseases in Southern Africa Incorporating Climate Predictions

Project Duration: 12 May 2014 - 31 March 2019

Target Area: The Limpopo Province of the Republic of South Africa

Project Administration:

Project Director: Chief Director, Biotechnology, Department of Science and Technology (DST)

Project Co-Director: Chief Director, District Health Services, National Department of Health (NDOH)

Chief Advisor: Institute of Tropical Medicine, Nagasaki University (NU)

Target Group :

Dairect Beneficiaries: Approximately 30 researchers (the Applied Centre for Climate and Earth Systems Science (ACCESS): 1, the South African Medical Research Council (MRC): 13, The Council for Scientific and Industrial Research (CSIR): 5, the Department of Health-Limpopo: 1, the Department of Health-Limpopo, Malaria Control (DOHL-Malaria): 1, the University of Cape Town (UCT): 1, the University of Limpopo (UL): 4 and the University of the Western Cape (UWC): 2, the University of Pretoria (UP): 1

Indirect Beneficiaries: Residents in the Limpopo Province: 5.4 million

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Project Purpose			
A climate-based early-warning system model for infectious diseases control is established as a precursor for further application across southern Africa.	(1) The iDEWS, the installation guide, the operational guidelines, operational costs, etc. are packaged as a precursor model for disseminating to other areas by the end of the project period. (2) The iDEWS is presented to relevant South African authorities as a tool by the end of the project period.	(1) Official report that represents the presentation of iDEWS to the relevant authorities. (2) Project report(s)	
Outputs			
1 Climate-based infectious disease epidemic prediction models are developed especially for malaria, pneumonia and diarrhea.	(1) The iDEWS for malaria is developed with the prediction performance of XX with XX-month lead time by October 2018. (2) The iDEWS for diarrhea is developed with the prediction performance of YY with YY-months lead time by October 2018. (3) The iDEWS for pneumonia is developed with the prediction of ZZ with ZZ-month lead time by October 2018. (4) More than 4 research papers first and/or co-authored by both Japan and South Africa collaborators related to iDEWS, infectious disease mathematical and statistical models, short-term climate variability prediction system, relationship between climate variability and infectious diseases are published in peer-reviewed internationally recognized journals. *Annotation: Numerical targets and/or objective situation of the Indicators (1), (2) and (3) that explain the prediction performances will be determined by October 2016 on the basis of the results of project research activities and discussions among relevant parties.*	(1) Scientific research articles in reputed international journals (2) Project report(s)	
2 Operational guidelines of the climate prediction-based infectious diseases early warning system (iDEWS) are developed for the Limpopo Province.	(1) The preparatory committee for iDEWS operation is launched at the Limpopo Province by October 2016. (2) The iDEWS operational guidelines is considererd by the authority/-ies concerned by October 2017.	(1) Project report (2) iDEWS operational guidelines (3) Letter of acknowledgement from respective authorities	

3 Prediction performance and operability of the iDEWS are verified.	(1) Prediction performance and operability of the iDEWS are evaluated by a pilot application at the Limpopo Province by May 2018. (2) Adaptability of the iDEWS to other areas including other provinces and neighboring countries is presented to appropriate authorities by October 2018.	(1) Project reports (2) Meeting minutes with appropriate authorities	
Activities	**Inputs**		
1 Climate-based infectious disease epidemic prediction models are developed especially for malaria, pneumonia and diarrhea.	**Japan**	**South Africa**	
1-1. Prospective and retrospective data/information acquisition systems are developed in the areas of infectious diseases and climate variability 1-1-1. To develop databases of data/information of malaria, pneumonia and diarrhea respectively from local health information system, archival records of health facilities and so on. 1-1-2. To determine investigation target sites on the basis of a risk map for respective diseases, which is developed using retrospective data from the database. 1-1-3. To conduct fact-finding surveys at communities in the targeted sites with regard to incidence and prevalence of respective diseases (including undiagnosed diseases), residents' behavior that impacts on the prevalence (health seeking behavior, etc.) and hygienic environment (water quality, air pollution, malaria mosquito insecticide resistance etc.), followed by populating the data into the database. 1-1-4. To source climatic and non-climatic ancillary environmental data (geographic data, etc.) from ACCESS partner organizations such as the South African Weather Service (SAWS) and the Agricultural Research Council (ARC). 1-1-5. To observe local-scale meteorological data in the target sites by placing basic observation stations at public buildings. 1-2. Elucidation of relationships among incidence/prevalence of the target diseases and climate variability (ambient temperature, humidity, precipitation, etc.). 1-2-1. To investigate the relationship between incidence/prevalence of the target diseases and climate variability using time-series analysis. 1-2-2. To investigate the relationships of proliferation of malaria vectors with climate variability and malaria incidence/prevalence. 1-2-3. To investigate the relationship between regional-scale climate variations in the Limpopo Province and their links with the global climate phenomena such as the El Nino Southern Oscillation (ENSO), the Indian Ocean Dipole Mode (IODM) and the Sub-tropical Dipole Mode (SDM).	(1) Chief Advisor; (2) Project Coordinator; (3) Other Experts in Epidemiology, Medical Entomology, Climate Dynamics, Public Health and other necessary areas; (4) Training in Japan for Climate Disease Modeling; (5) Necessary equipment for research and development activities; and (6) Running expenses necessary for implementation of the Project activities other than that borne by the South African side.	(1) Research Scientists in Epidemiology, Medical Entomology, Climate Dynamics and other related areas; (2) Research Staff and Laboratory Technicians; (3) Office space at ACCESS, UL and DOHL-Malaria; (4) Laboratory space at DOHL-Malaria; (5) Existing Equipment at MRC, CSIR, UL and DOHL-Malaria; (6) Available data, information and specimens related to the Project; and (7) Support to project activities will be made available in accordance with the laws and regulations in force in South Africa, and subject to the availability of resources.	Necessary cooperation is gained by external project supporters (e.g. SAWS, ARC and superintendents of public buildings, etc.)

1-3.	Development of infectious disease mathematical and/or statistical models for malaria, and statistical models for pneumonia and diarrhea of which local epidemic situation is reflected.
1-3-1.	To review existing infectious disease models (related to climate in particular) for malaria, cholera, and pneumonia.
1-3-2.	To develop basic mathematical and/or statistical models for malaria, and statistical models for pneumonia and diarrhea by modifying existing model(s) or newly developing.
1-3-3.	To calibrate the models by verifying their prediction performance using retrospective and prospective data/information of infectious diseases obtained from the database.
1-4.	Improvement of a seasonal prediction system based on an ocean-atmosphere coupled general circulation model (CGCM) called SINTEX-F; improving its skill, downscaling, extending its lead-time
1-4-1.	To improve the prediction accuracy of SINTEX-F for the short-term seasonal climate variability by enhancing model resolution, implementing better physics and data assimilation in next versions of SINTEX-F on the Earth Symulator.
1-4-2.	To reduce model biases by model validations and intercomparisons among SINTEX-F1, new SINTEX-F2 and other climate models (ECHAM4.5-MOM-SA, and CCAM) develped in South Africa.
1-4-3.	To improve resolution and lead time for climate prediction of the SINTEX-F for better local-scale prediction performance by using a dynamical downscaling model such as Weather Research and Forecasting model (WRF) and statistical downscaling techniques.
1-4-4.	Interactively with the Activity 1-4-3, to fine-tune WRF downscaling model using local data available from the weather and climate observations at the target areas (Activity 1-1).
1-5.	Development of the climate-based infectious disease prediction models for malaria, pneumonia and diarrhea
1-5-1.	To develop a climate-based infectious disease epidemic prediction models for malaria, pneumonia and diarrhea by coupling the infectious disease mathematical and statistical models and the adopted climate prediction model, in light of the relationships among incidence/prevalence of the target diseases, climate variability and proliferation of vectors (Activity 1-2).
1-5-2.	To calibrate the models by verifying their prediction performance using existing data/information of infectious diseases epidemics and outbreaks obtained from the database.

2	**Operational guidelines of the climate prediction-based infectious diseases early warning system (iDEWS) are developed for the Limpopo Province.**			
	2-1.	To launch a preparatory committee for introducing the iDEWS at the Limpopo Province consisting of organizations responsible for epidemic prediction, issuing epidemic/alerting information and implementing countermeasures based on such information.		
	2-2.	To set criteria for outbreak alerting.		
	2-3.	To set communication flow of infectious diseases epidemic/outbreak information in the Limpopo Province.		
	2-4.	To develop an iDEWS operational Guidelines comprising regular reporting of epidemics, issuing outbreak alerting and consequent countermeasures, organogram of iDEWS operation, formats of regular reporting and alerting, etc.		
3	**Prediction performance and operability of the iDEWS are verified.**			
	3-1.	To evaluate the prediction performance and operability of the iDEWS through a pilot application at the Limpopo Province.		
	3-2.	To conduct table-top exercises regarding issuing outbreak alerting and consequent countermeasures at the Limpopo Province.		
	3-3.	To develop a sustainable monitoring and evaluation system for assessing impacts of the iDEWS on infection control at the Limpopo Province.		
	3-4.	To verify the applicability of other areas using available data of epidemics, climate and non-climate environment at other provinces of the South Africa and neighboring countries.		
	3-5.	To hold workshop(s) geared to administrative officers, researchers, etc. in the areas of climate variability and infection control from the government of the South Africa and neighboring countries for the deployment of iDEWS.		
	3-6.	To start discussions with administrative officers, researchers, etc. in the areas of climate variability and infection control of the government of the South Africa for the dissemination of iDEWS.		

Pre-conditions
1. Research permissions are obtained by the relevant authority/-ies of South Africa where necessary.
2. Approvals are obtained for medical researches and related interventions/investigations by the ethical committees of the Institute of Tropical Medicine, the Nagasaki University, MRC and other related organizations to the project activities.

Annex 2: Schedule of Mid-term Review

			JICA Dr. Kaname Kanai (JICA Mission Leader)	JICA Ms. Saya Uchiyama (JICA Officer)	JICA Dr. Inoue JICA Consultant (Evaluation Analysis)	AMED Prof. Haruo Watanabe (Project Officer), Mr. Katusmi Ishii (AMED officer)
18 Sep	Sun	A.M.	-	-	Arrival at Johannesburg(CX505)	-
		P.M.	-	-	Preparation	-
19 Sep	Mon	A.M.	-	-	Visit JICA S.A., Interview Mr. Hirau	-
		P.M.	-	-	13:00 Interview Prof. Willmem Landman@UP 15:00Interview Prof. F. Engelbrecht@CSIR	-
20 Sep	Tue	A.M.	-	-	08:45Interview Dr. Caradee Wright (MRC)@CSIR	-
		P.M.	-	-	15:00 Prof. Rajendra Maharaj@MRD-D	-
21 Sep	Wed	A.M.	-	-	Travel from Durban	-
		P.M.	-	-	Preparation	-
22 Sep	Thu	A.M.	-	-	9:00 TV Interview Dr. Neville Sweijd (ACCESS) 11:00 TV Intervie Prof. Peter Witbooi (UWC)	-
		P.M.	-	-	Visit SAWS	-
23 Sep	Fri	A.M.	-	-	Preparation	-
		P.M.	-	-	Preparation	-
24 Sep	Sat	A.M.	Arrival at Johannesburg (S A237)	-	Preparation	-
		P.M.	Preparation with internal members	-	Same with Dr. Kanai	-
25 Sep	Sun	A.M.	Preparation with internal members	-	Same with Dr. Kanai	-
		P.M.	Preparation with internal members	-	Same with Dr. Kanai	-
26 Sep	Mon	A.M.	Travel to Tzaneen 10 : 00 Interview Mr. Philip Kruger @DOHL, 12 : 00 Interview Prof. Kingsley Ayisi @Univ. Limpopo	-	Same with Dr. Kanai	-
		P.M.	Travel to Tzaneen	-	Same with Dr. Kanai	-
27 Sep	Tue	A.M.	08:00 Labo investigation @Malaria Institute with Dr. Ataru Tsuzuki. 08:30 Travel to G.Gyani Field sites 10:30-13:00 G.Giyani Field site (incl. Local clinics) 16:00 Additional Interview Dr. Ataru Tsuzuki	-	Same with Dr. Kanai	-
		P.M.	16:00 Additional Interview Dr. Ataru Tsuzuki	-	Same with Dr. Kanai	-
28 Sep	Wed	A.M.	Return to Pretoria	-	Same with Dr. Kanai	Arrival at Johannesburg
		P.M.	Internal Meeting (JICA, AMED) for 1st evaluation report with First Draf, Briefing			
29 Sep	Thu	A.M.	Scientific Meeting (as symposium) @DST Auditorium			
		P.M.	Drafting Report and Minutes→Email to C/P			
30 Sep	Fri	A.M.	9:00-12:00 Discussion on evaluation, preparation for Evaluation Report & Minutes	-	Same with Dr. Kanai	Same with Dr. Kanai
		P.M.	(Spare time)Discussion on evaluation, preparation for Evaluation Report & Minutes	Arrival at Johaneesburg	Same with Dr. Kanai	Move to Tzaneen
Oct 1	Sat	A.M.	Internal review & revision on report			Labo visit@TMI, G.Gyani Field visit
		P.M.	Internal review & revision on report			G.Gyani Field visit
Oct 2	Sun	A.M.	Internal review & revision on report			
		P.M.	Finalize Report and Minutes→Email to C/P			Return to Pretoria
Oct 3	Mon	A.M.	10:00 Reporting to JICA SA Office, (Spare time) Discussion for Report& Minutes			
		P.M.	Preparation for JCC etc.			
Oct 4	Tue	A.M.	9:00-13:00 Joint Coordinating Committee (JCC)			
		P.M.	Spare time for JCC meeting			

別添 3. 評価グリッド

3-1 実施プロセスの検証

Annex 3-1 Evaluation Grid (Verification of Implementation Process)

Evaluation Item	Evaluation Classification: Major	Evaluation Classification: Small	Criteria	Necessary data and Information	Data Source	Means of Verification
Probability of achievement of the Project	Project Purpose	Whether the Project Purpose of "*A climate-based early-warning system model for infectious diseases control is established as a precursor for further application across southern Africa*" is expected to be achieved by the end of the project period.	① Degree of achievement of Objectively Verifiable Indicators (OVIs) ② Comprehensive analysis	① Achievements of OVIs ② Views of related players	① Project documents ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
	Outputs	Whether the Output 1 of "*Climate-based infectious disease epidemic prediction models are developed especially for malaria, pneumonia and diarrhoea*" is achieved or expected to be achieved by the end of the project period.	Degree of achievement of OVIs	① Achievements of OVIs ② Views of related players	① Project documents ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
		Whether the Output 2 of "*Operational guidelines of the climate prediction-based infectious diseases early warning system (iDEWS) are developed in the Limpopo Province*" is achieved or expected to be achieved by the end of the project period.		① Achievements of OVIs ② Views of related players	① Project documents ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
		Whether the Output 3 of "*Prediction performance and operability of the iDEWS are verified*" is achieved or expected to be achieved by the end of the project period.		① Achievements of OVIs ② Views of related players	① Project documents ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
Inputs	Inputs from the Japanese Side	Whether JICA Experts were dispatched as scheduled.	Comparison of plan with actual result	Results of Input	① Input records ② Project reports	Document review
		Whether equipment for project activities was provided as planned.		Results of Input (incl. Information for status of utilization)	① Input records ② Project reports	① Document review ② Direct observation
		Whether C/Ps' training in Japan and/or third countries were implemented as planned.		Results of acceptance of trainees	① Input records ② Project reports	Document review
		Whether local cost from JICA side were implemented as scheduled.		Budget and implementation result	① Input records ② Project reports	Document review
	Inputs from the South African side	Whether C/Ps were appropriately allocated enough to implement project activities.		① Achievement of Input ② Views of related players	① Input records ② Experts, C/P	① Document review ② Interview
		Whether office space for JICA experts was provided.		Achievement of Input	① Input records ② Experts, C/P	① Document review ② Interview
		Whether local cost from Zambian side were implemented appropriately.		① Achievement of Input ② Views of related players	① Input records ② Experts, C/P	① Document review ② Interview
Implementation Process	Planned activities	Whether the project activities were implemented as scheduled.	Comparison of plan with actual result	Accomplishment of project activities	Project reports	① Document review ② Questionnaire
		Whether the PDM was updated in accordance with surroundings of the Project under the agreement amongst relevant parties.		Vicissitude of PDMs and its reasons for modification	Meeting minutes of the Joint Coordinating Committee (JCC)	① Document Review ② Questionnaire ③ Interview
	Technical transfer	Whether methods and/or approaches of technical transfer were appropriate.		Methods and contents of technical transfer	① Project reports ② Experts, C/P	① Document review ② Interview
	Management system	Who, how and how often the progress of the Project was monitored, and consequent findings were reflected to the operation of the Project.		① Progress monitoring system ② Feedback system	① Project reports ② Experts	① Document review ② Questionnaire
		How the decision-making process for modification of the project activities, assignment of		Process for decision-	① Project reports	① Document review

Annex 3-1 Evaluation Grid (Verification of Implementation Process)

Evaluation Item	Evaluation Classification		Criteria	Necessary data and Information	Data Source	Means of Verification
	Major	Small				
		personnel, etc was.		making	② Experts	② Questionnaire
		How the communication and cooperative relationship amongst players in the Project was.		JCC and other meeting	① Project reports ② Views of related players	① Document review ② Questionnaire
		Whether Project information was effectively shared.		JCC and other meetings minutes	① Project reports ② Views of related players	① Document review ② Questionnaire
	Ownership and Autonomy	How ownership and autonomy of implementing bodies including C/Ps and beneficiaries were.		Contribution, attitude, etc. for the project activities.	① Project reports ② Views of related players	① Document review ② Questionnaire ③ Interview
	Problems on implementation process	Whether there were obstacles or problems for the implementation of the project activities.		Contributing and inhibitory factors	① Project reports ② Views of related players	① Document review ② Questionnaire ③ Interview

Annex 3-2 Evaluation Grid (Five Evaluation Criteria)

Five Criteria	Evaluation Classification: Major	Middle	Small	Criteria	Necessary data and Information	Data Source	Means of Verification
Relevance	Priority	Consistency of the Project Purpose with South African policies with regard to health (infectious disease control), the prediction of climate variability and/or the development of science and technology.		Comparison with South African policies	Related policies in South Africa	① Document for related policies ② Related authorities such as the Department of Science & Technology (DST) and the National Department of Health (NDOH)	① Document review ② Interview ③ Questionnaire
		Consistency with Japan's ODA policies and JICA's aid policies	Relativity with prioritized area in Japan's ODA policies	Comparison with South African health related policies	Prioritized area in Japan's ODA policies for South Africa	① Japan's ODA policies for South Africa ② Basic Design for Piece and Health (Global Health Cooperation)	Document review
			Relativity with prioritized area in JICA's aid policies	Comparison with South African health related policies	Place of health assistance in the JICA's aid policies	JICA Country Analysis Paper for South Africa (March 2016)	Document review
	Necessity	Relevance of target group	Consistency of needs of target group with the Project Purpose		① Experiences and capacity of counterpart organizations (C/Ps) ② Epidemic situation of infectious diseases such as malaria, pneumonia and diarrhoeal diseases in the South Africa especially in the Limpopo province	① Project documents ② JICA Experts, C/P ③ Health statistics reports	① Document review ② Interview
	Appropriateness of implementation method	Appropriateness of research design (incl. target diseases) and approaches in the framework of SATREPS			Background and/or process for determining research design and/or approaches	① JICA ex-ante evaluation report ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
		Special consideration	Special assiduities for gender issues, environment, social grades, environment, ethnic groups, etc.		Views of related players	① JICA Experts ② JICA HQ	① Document review ② Interview
		Japan's technical superiority			① Assistance record of Japan in health sector ② Assistance experiences of Japan in the area of the prediction of climate variability ③ Skills and experiences of JICA experts	① Project documents ② JICA HQ ③ JICA Experts	① Document review ② Interview
Effectiveness	Achievements	Status of the achievements of Outputs	Whether it can be said that research implementation system(s) for the prediction of climate variability, the development of climate-based infectious disease prediction models and the development of the climate prediction-based infectious diseases early warning system (iDEWS) are developed or anticipated to be developed at an expected level by the end of the project period.		① Status of achievements of OVIs ② Outputs other than the scope of the project activities	① Project documents ② JICA Experts, C/P	① Document review ② Interview
			<Output 1> Whether it can be said that climate-based infectious disease epidemic prediction models for malaria,		① Status of achievements of OVIs ② Outputs other than the scope of	① Project reports ② JICA Experts, C/P	① Document review ② Interview

Annex 3-2 Evaluation Grid (Five Evaluation Criteria)

Five Criteria	Evaluation Classification: Major	Middle	Small	Criteria	Necessary data and Information	Data Source	Means of Verification
			pneumonia and diarrhoea are developed or anticipated to be developed at an expected level by the end of the project period.		the project activities		③ Direct observation
			<Output 2> Whether it can be said that operational guidelines for malaria, pneumonia and diarrhoea are developed or anticipated to be developed in the Limpopo province by the end of the project period.		① Status of achievements of OVIs ② Outputs other than the scope of the project activities	① Project reports ② JICA Experts, C/P	① Document review ② Interview ③ Direct observation
			<Output 3> Whether it can be said that climate-based infectious disease epidemic prediction models for malaria, pneumonia and diarrhoea are developed or anticipated to be developed at an expected level by the end of the project period.		① Status of achievements of OVIs ② Outputs other than the scope of the project activities	① Project reports ② JICA Experts, C/P	① Document review ② Interview ③ Direct observation
		Probability of the achievement of the Project Purpose	Whether it can be said that prediction performances and operability of the iDEWS for malaria, pneumonia and diarrhea are verified or anticipated to be verified by the end of the project period at an expected level	Comprehensive judgment	① Status of achievements of OVIs ② Outputs other than the scope of the project activities	① Project reports ② JICA Experts, C/P	① Document review ② Interview ③ Direct observation
	Cause-and-effect relationship	Whether the Project Purpose was attained as a result of the achievements of Outputs	Whether there was no logical error from the aspect of cause-and-effect relationship.	Verification of logical relationship	Verification by Evaluation Team	① Project documents ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
			Whether there was any other effective approaches for the achievement of the Project Purpose	Verification of implementation approaches	① Verification by Evaluation Team ② Views of related parties	① Project documents ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
	Contributing and inhibitory factors	Appropriateness of the important assumptions	Whether important assumptions are appropriate from aspects of current situation.	Confirmation current situation	Verification by Evaluation Team	① Project documents ② JICA Experts, C/P	① Document review ② Interview
			Whether important assumptions are appropriate from aspects of current situation and logical relationship	Verification of logical relationship	Verification by Evaluation Team	① Project document ② JICA Experts, C/P	① Document review ② Interview
		Whether important assumptions are fulfilled.	Confirmation of the current status of "*Necessary cooperation is gained by external project supporters (e.g. the National Department of Health, SAWS, ARC and superintendents of public buildings, etc.) for the project activities.*		Records of communications and collaborations with the said external supporters	① Project documents ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
			Confirmation of the current status of "*Counterparts do not leave their position so as to affect the outputs of the Project*" as an envisaged important assumption.		Turnover rate of South African researchers	① Project documents ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
			Other unexpected factors		① Views of related players ② Other expected and/or unexpected external factors	① JICA Experts, C/P ② Project documents	① Document review ② Questionnaire ③ Interview
Efficiency	Time resource	Whether Outputs were attained as scheduled.			Progress control of the project activities	① Project documents ② Views of related players	① Document review ② Questionnaire ③ Interview
	Quality, quantity and timing of inputs	Whether quality, quantity and timing of inputs were appropriate.	Whether the number and period, areas of expertise and timing of dispatch of JICA expert were appropriate.	Comparison of results and plan	① Record of dispatch of experts ② ｳ Attitude and performance of experts	① Input records ② Project documents ③ JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
			Whether types, quantity and timing of installation were appropriate.		① Record of equipment provision ② Utilization status of equipment	① Input records ② JICA Experts, C/P	① Document review ② Questionnaire ③ Direct observation

Annex 3-2 Evaluation Grid (Five Evaluation Criteria)

Five Criteria	Evaluation Classification: Major	Middle	Small	Criteria	Necessary data and Information	Data Source	Means of Verification
							④ Interview
			Whether timing, contents and duration of training in Japan and/or third countries were appropriate, and how the training contributed for the achievement of Outputs.		① Acceptance of trainees ② Views of related parties	① Input records ② Trainees ③ JICA Experts	① Document review ② Questionnaire ③ Interview
			Whether timing, contents, duration follow-up of on-site trainings were appropriate.		① Records of on-site trainings ② Accomplishments of trainings	① Project documents ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
			Whether the budget for local costs was appropriate.		Local costs from Japan side	① Input records ② JICA Experts	① Document review ② Interview
			Whether allocation of South African C/Ps and budget for the Project were appropriate.		Local costs from the South African side	① Input records ② JICA Experts, C/P	① Document review ② Questionnaire ③ Interview
		Collaboration with other resources	Whether there were any collaboration with other resources contributed for the achievement of Outputs.		Benefits derived from collaborative activities with other development partners.	① Project documents ② JICA Experts ③ Other development partners	① Document review ② Questionnaire
		Whether there were any contributing factors to efficiency.			Views of related parties	① Project documents ② JICA Experts, C/P	① Document review ② Interview
		Whether there were any inhibitory factors to efficiency.			Views of related parties	① Project documents ② JICA Experts, C/P	① Document review ② interview
Impact	Probability of achievement of (envisaged) Overall Goals	(Envisaged Overall Goal) Whether the climate variability prediction system, fine-tuned by the Project (SINTEX-F2) and/or short-term climate variability prediction system, newly-developed by the Project are anticipated to be utilized by alternative fields other than the infection disease control after the end of the project period by the self-help efforts of the South African side.		Exploration based on the current status	① Degree of achievement of the Project Purpose ② Verification of Sustainability	① Project documents ② Views of related players	① Document review ② Questionnaire ③ Interview
		(Envisaged Overall Goal) Whether the iDEWS are anticipated to be applied for infectious disease control in other provinces in the South Africa and/or neighboring countries such as Mozambique by the self-help endeavor of the South Africa.		Exploration based on the current status	① Degree of achievement of the Project Purpose ② Verification of Sustainability	① Project documents ② Views of related players	① Document review ② Questionnaire ③ Interview
	Other impacts	Whether there are any positive and/or negative impacts confirmed and/or expected to be generated other than Overall Goal	Positive impacts		Other necessary information	① Project reports ② JICA Experts, C/P ③ Views of related players	① Document review ② Questionnaire ③ Interview
			Negative impacts		Other necessary information	① Project reports ② JICA Experts, C/P ③ Views of related players	① Document review ② Questionnaire ③ Interview
Sustainability	Probability of maintaining the benefits derived from the Project	Political and institutional aspects	Whether the policies related to health (infection control), climate variability and science and technology would be maintained and/or enhanced.		South African related policies	① Related authorities such as the NDOH and the DST ② JICA Experts, C/P ③ Views of related players	① Document review ② Questionnaire ③ Interview
		Financial aspect	Whether the budget for benefits derived from the Project will be maintained in the south regions.		South African related policies and budget	① Related authorities such as the NDOH and the DST ② JICA Experts, C/P ③ Views of related players	① Document review ② Questionnaire ③ Interview
			Whether the budget and personnel for the enhancement of the benefit will be allocated.		South African related policies and budget	① Related authorities such as the NDOH and the DST	① Document review ② Questionnaire

Annex 3-2 Evaluation Grid (Five Evaluation Criteria)

Five Criteria	Evaluation Classification: Major	Middle	Small	Criteria	Necessary data and Information	Data Source	Means of Verification
						② JICA Experts, C/P ③ Views of related players	③ Interview
		Technical aspect	Whether the research techniques provided by the Project will be maintained and enhanced autonomously.		① Presence of maintenance mechanism for of technical benefits ② Opportunities to update technical skills	① Project reports ② JICA Experts, C/P ③ Views of related players	① Document review ② Questionnaire ③ Interview
		Contributing and inhibitory factors	Whether countermeasures against envisaged inhibitory factors for sustainability were discussed by the Project and C/Ps.		Views of related players	① Project reports ② JICA Experts	① Questionnaires ② Interview
	Comprehensive sustainability	Whether the comprehensive sustainability is secured or not, in the view of above-mentioned aspects.			Views of related players	① Project documents ② JICA Experts, C/P ③ Views of related players	Analytical evaluation by the Evaluation Team

Annex 4: List of Interviewees

1. **Department of Science and Technology (DST)**

Ms. Queeneth Gcino Mlaba	Deputy Director-Development Partnerships
Ms. Modiegi Pertunia Selematsela	Deputy Director-Health Innovation

2. **Applied Centre for Climate and Earth Systems Science (ACCESS)**

Dr. Neville Anthony Sweijd	Director (Project Manager)
Mr. Jiro Hirau	Project Coordinator (JICA Expert)

3. **Council for Scientific and Industrial Research (CSIR)**

Prof. Francois Engelbrecht	Principal Researcher
Ms. Mary-Jane Bopape	Postdoctoral Research Fellow
Mr. Mthetho Vuyo Sovara	Ph.D. Studentship (UCT)

4. **South African Medical Research Council (MRC)**

Prof. Rajendra Maharaj	Director-Durban
Dr. Caradee Wright	Specialist Scientist
Dr. Natashia Morris	Senior Scientist
Ms. Ngoza Thandi Ethel Kapwata	GIS Research Technologist
Ms. Zamantimande Kunene	Senior research technologist
Ms. Mirriam Mogotsi	Research Technologist
Mr. Wellington Siziba	Research Trainee/ Intern

5. **South African Weather Service**

Dr. Nhlonipho N. Nhlabatsi	Senior Manager
Dr. Cornelis J. de Wet Rautenbach	Senior Scientist
Dr. Asmerom Beraki	Researcher
Ms. Katlego Ncongwane	Scientist

6. **Department of Health-Limpopo (DOH-L)**

Mr. Philip Kruger	Acting Chief Director
Ms. Marlene Freda Ngobeni	Director: Public Health Program

7. **Department of Health-Limpopo, Malaria Control (DOHL-Malaria)**

Mr. Erik Mabunda	Senior Manager

8. **University of Pretoria(UP)**

Prof. Willem Adolf Landman	Professor
Dr. Vusumuzi Nkosi	Post Doctoral Fellow

9. **University of Limpopo (UL)**

Prof. Kingsley Kwabena Ayisi	Associate Professor
Prof. Yehenew G. Kifle	Associate Professor

10. **University of the Western Cape (UWC)**

Prof. Peter Witbooi	Professor

11. University of Venda (UV)

Mr. Hector Chikoore	Lecturer

12. Ministry of Health (Republic of Mozambique)

Dr. Francisco Siedade Mbofana	Director-Public Health

13. National Malaria Control Program (Republic of Mozambique)

Dr. Nelson Jacinto Bambo Cuamba	Senior Entomologist

14. Nagasaki University Institute of Tropical Medicine (NEKKEN)

Prof. Noboru Minakawa	Professor (Chief Advisor)
Prof. Masahiro Hashizume	Professor
Dr. Ataru Tsuzuki	Assistant Professor (JICA Expert)
Dr. Yoonhee Kim	Assistant Professor
Dr. Chisato Imai	Guest Researcher

15. Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Dr. Swadhin Behera	Principal Researcher
Dr. Venkata Ratnam Jayanthi	Senior Researcher
Dr. Takeshi Doi	Researcher
Dr. Yushi Morioka	Researcher
Dr. Takayoshi Ikeda	Project Scientist

別添 5. 投入実績表

5-1 プロジェクト・メンバー表

Annex 5-1: List of Project Members

The Japanese Side

Group Leader	Name	Organisation	Position (Title)	Duration				Note
				Start		End		
				Year	Month	Year	Month	
o	Noboru Minakawa	Nagasaki University	Professor	25	5	31	3	
	Ataru Tsuzuki	Nagasaki University	Assistant Professor	26	8	31	3	
	Yukiko Higa	Nagasaki University	Assistant Professor	25	5	31	3	
	Kyoko Futami	Nagasaki University	Assistant Professor	25	5	31	3	
	Peter Sean Larson	Nagasaki University	Assistant Professor	27	5	31	3	
o	Masahiro Hashizume	Nagasaki University	Professor	25	5	31	3	
	Yoonhee Kim	Nagasaki University	Assistant Professor	25	5	31	3	
	Chisato Imai	Nagasaki University	Ph. D Student	27	5	27	9	Position Changed in Oct 2015
	Chisato Imai	Nagasaki University	Guest Researcher	27	10	31	3	
o	Swadhin K. Behera	JAMSTEC	Principal Researcher	25	5	31	3	
	Shingo Iwami	Kyushu University	Associate Professor	25	5	31	3	
	Ratnam V. Jayanthi	JAMSTEC	Senior Reserche	25	5	31	3	
	Takeshi Doi	JAMSTEC	Researcher	25	5	31	3	
	Yushi Morioka	JAMSTEC	Researcher	25	5	31	3	
	Takayoshi Ikeda	JAMSTEC	Researcher	26	11	31	3	
	Tomoki Tozuka	JAMSTEC	Senior Reserche	25	5	31	3	
	Naoko Miyamoto	JAMSTEC	Senior Research Administrator	25	5	27	3	

The South African Side

Group Leader	Name	Organisation	Position (Title)	Duration				Note
				Start		End		
				Year	Month	Year	Month	
o	Rajendra Maharaj	South African Medical Research Council	Director, MRC Office for Malaria Research	25	5	31	3	
	Philip Kruger	Tzaneen Malaria Institute in Limpopo Province	Senior Manager	25	5	31	3	
	Natashia Morris	South African Medical Research Council	Research Support Manager	25	5	31	3	
	Tsundzukani Masesi	University of Limpopo	Master Course Student (Also a staff of Dept. Health Limpopo assigned for Tzaneen Malaria Institute)	27	8	31	3	
	Ngoza Thadi E. Kapwata	South African Medical Research Council	GIS Research Technologist	27	8	31	3	
	Jaishree Raman	National Institute of Communicable Diseases	Medical Scientist	27	8	31	3	
	Lyn-Marie Birkholtz	University of Pretoria, Department of	Professor.	27	8	28	3	
	Shefu Awandu	University of Pretoria, Department of	Ph.D. student	27	8	31	3	
o	Angela Mathee	South African Medical Research Council	Director, Environment & Health Research Unit	25	5	31	3	
	Caradee Wright	South African Medical Research Council	Specialist Scientist	27	4	31	3	Institute Changed in 2015
	Eric Maimela	Department of Health, Limpopo Province	Epidemiologist	25	5	31	3	
	Nisha Naicker	South African Medical Research Council	Specialist Scientist	25	5	31	3	
	Tahira Kootbodien	South African Medical Research Council	Senior Scientist	25	5	27	3	
	June Teare	South African Medical Research Council	Senior Scientist	25	5	31	3	
	Patricia Albers	South African Medical Research Council	Researcher	25	5	28	6	
	Louise Renton	South African Medical Research Council	Chief Research Technologist	25	5	31	3	
	Thandi Zwane	South African Medical Research Council	Senior Research Technologist	25	5	31	3	
	Mirriam Mogotsi	South African Medical Research Council	Research Technologist	25	5	31	3	
	Ishen Seocharan	South African Medical Research Council	Senior Scientist	25	5	31	3	
	Wellington Siziba	South African Medical Research Council	Research Trainee	25	5	31	3	
o	Kingsley Ayisi	University of Limpopo	Associate Professor	25	5	31	3	

	Yehenew G. Kifle	University of Limpopo	Associate Professor	28	7	31	3	
	Dhau Inos	University of Limpopo	Lecturer	25	8	31	3	
	Elhadi Adam	University of Limpopo	Researcher	25	5	27	8	
	Brilliant Petja	University of Limpopo	Scientific Manager Limpopo Department of	25	5	31	3	
	Simon Ndou	University of Limpopo	Technical Researcher	25	5	31	3	
	Afuwani Ramalata	University of Limpopo	Junior Lecturer	27	8	31	3	
	Natashia Morris	South African Medical Research Council	Senior Scientist	25	5	31	3	
	Coleen Vogel	University of Pretoria	Professor	25	5	27	8	
	Michael Mengistu	South African Weather Service	Senior Scientist	28	1	31	3	
o	Peter Wootbooi	Unviersity of Western Cape	Professor	25	5	31	3	
	Joel Ondego Botai	South African Weather Service	Chief Scientist	28	4	31	3	
	Katlego Ncongwane	South African Weather Service	Scientist	28	7	31	3	
	Gbenga Jacob Abiodun	Unviersity of Western Cape	Ph.D. Course Student	27	8	28	7	
	Emma Archer Van Garderen	Council for Science and Industrial Research	Principal Scientist	25	5	31	3	
	Caradee Wright	Council for Science and Industrial Research	Senior Researcher	25	5	27	3	Institute Changed in 2015
	John O. Odiyo	University of Venda	Professor	28	8	31	3	
o	Willem A. Landman	Council for Science and Industrial Research	Chief Researcher	25	5	27	12	Institute Changed in 2016
o	Willem A. Landman	University of Pretoria	Professor	28	1	31	3	
	Cornelis Johannes de Wet Rautenbach	South African Weather Service	Senior Scientist	28	4	31	3	
	Asmerom Beraki	South African Weather Service	Researcher	25	5	31	3	
	Francois Engelbrecht	Council for Science and Industrial Research	Reseach Group Leader	25	5	31	3	
	Mthotho Vuyo Sovara	Council for Science and Industrial Research	Ph.D Student	28	4	31	3	
	Babatunde Abiodun	University of Cape town	Senior Lecturer	25	5	31	3	
	Chris Lennard	University of Cape town	Senior Researcher	25	5	31	3	
	Rebecca Garland	Council for Science and Industrial Research	Senior Researcher	25	5	31	3	
	Hector Chikoore	Univeristy of Venda	Lecturer	25	5	31	3	
	Sandile Ngwenya	Univeristy of Venda	Postgraduate Student	27	8	31	3	
	Nkosinathi Xulu	Univeristy of Venda	Postgraduate Student	28	4	31	3	
	Mary-Jane Bopape	Council for Science and Industrial Research	Postdoctoral Research Fellow	25	5	31	3	
	Stephanie Landman	Applied Centre for Climate and Earth	Senior Scientist	25	5	28	3	
o	Neville Sweijd	Applied Centre for Climate and Earth	Acting Director	25	5	31	3	
	Nhlonipho N. Nhlabati	South African Weather Service	Senior Manager	28	4	31	3	
	Hanna-Andrea Rother	University of Cape town	Associate Professor and Division Head of	25	5	31	3	
	Julia Mambo	Council for Science and Industrial Research	Physical geographer in the Climate Studies,	25	5	31	3	

Annex 5-2: Dispatch of JICA Experts

Long-term Experts

as of June, 2016

No	Name	Job Title	Period
1	Ataru Tsuzuki (Mr.)	Expert (Infectious Diseases)	17 Oct 2014 - 30 June 2016
2	Jiro Hirau (Mr.)	Project Coordinator	01 Oct 2014 - 30 June 2016

Short-term Experts

No	Name	Job Title	Period
1	Prof. Noboru Minakawa (Mr.)	Chief Advisor	31 July - 16 Aug 2014
2	Prof. Masahiro Hashizume (Mr.)	Short-term Expert	01 Aug - 10 Aug 2014
3	Dr. Ataru Tsuzuki (Mr.)	Short-term Expert	01 Aug - 19 Aug 2014
4	Dr. Swadhin Behera (Mr.)	Short-term Expert	03 Aug - 10 Aug 2014
5	Dr. Takeshi Doi (Mr.)	Short-term Expert	03 Aug - 10 Aug 2014
6	Ms. Naoko Miyamoto (Ms.)	Short-term Expert	30 July - 10 Aug 2014
7	Dr. Yushi Morioka (Mr.)	Short-term Expert	03 Aug - 10 Aug 2014
8	Dr. Venkata Ratnam Jayanthi (Mr.)	Short-term Expert	03 Aug - 10 Aug 2014
9	Prof. Noboru Minakawa (Mr.)	Chief Advisor	31 Aug - 12 Sep 2014
10	Prof. Noboru Minakawa (Mr.)	Chief Advisor	24 Nov - 06 Dec 2014
11	Prof. Noboru Minakawa (Mr.)	Chief Advisor	03 May - 11 May 2015
12	Dr. Swadhin Behera (Mr.)	Short-term Expert	27 May - 06 Jun 2015
13	Dr. Yushi Morioka (Mr.)	Short-term Expert	27 May - 06 Jun 2015
14	Dr. Takayoshi Ikeda (Mr.)	Short-term Expert	27 May - 06 Jun 2015
15	Ms. Chisato Imai (Ms.)	Short-term Expert	27 May - 07 Jun 2015
16	Prof. Noboru Minakawa (Mr.)	Chief Advisor	28 May - 07 Jun 2015
17	Dr. Peter Larson (Mr.)	Short-term Expert	28 May - 07 Jun 2015
18	Prof. Masahiro Hashizume (Mr.)	Short-term Expert	31 May - 07 Jun 2015
19	Dr. Kyoko Futami (Ms.)	Short-term Expert	19 Jun - 30 Jun 2015
20	Prof. Noboru Minakawa (Mr.)	Chief Advisor	22 Jun - 30 June 2015
21	Prof. Noboru Minakawa (Mr.)	Chief Advisor	10 Oct - 17 Oct 2015
22	Dr. Peter Larson (Mr.)	Short-term Expert	10 Oct - 18 Oct 2015
23	Prof. Masahiro Hashizume (Mr.)	Short-term Expert	11 Oct - 18 Oct 2015
24	Dr. Yoonhee Kim (Ms.)	Short-term Expert	11 Oct - 18 Oct 2015
25	Dr. Chisato Imai (Ms.)	Short-term Expert	11 Oct - 18 Oct 2015
26	Dr. Swadhin Behera (Mr.)	Short-term Expert	10 Oct - 15 Oct 2015
27	Dr. Venkata Ratnam Jayanthi (Mr.)	Short-term Expert	10 Oct - 18 Oct 2015
28	Dr. Yushi Morioka (Mr.)	Short-term Expert	10 Oct - 18 Oct 2015
29	Prof. Dr. Motoyoshi Ikeda (Mr.)	Short-term Expert	10 Oct - 18 Oct 2015
30	Dr. Takayoshi Ikeda (Mr.)	Short-term Expert	10 Oct - 18 Oct 2015
31	Prof. Masahiro Hashizume (Mr.)	Short-term Expert	20 Apr - 25 Apr 2016
32	Dr. Swadhin Behera (Mr.)	Short-term Expert	20 Apr - 30 Apr 2016
33	Dr. Takayoshi Ikeda (Mr.)	Short-term Expert	20 Apr - 30 Apr 2016
34	Dr. Yushi Morioka (Mr.)	Short-term Expert	20 Apr - 30 Apr 2016
35	Prof. Noboru Minakawa (Mr.)	Chief Advisor	19 Apr - 29 Apr 2016
36	Dr. Peter Larson (Mr.)	Short-term Expert	21 Apr - 29 Apr 2016
37	Dr. Kyoko Futami (Ms.)	Short-term Expert	07 May - 20 May 2016
38	Prof. Noboru Minakawa (Mr.)	Chief Advisor	10 Jun - 14 Jun 2016
39	Dr. Takeshi Doi (Mr.)	Short-term Expert	06 Jun - 12 Jun 2016
40	Dr. Venkata Ratnam Jayanthi (Mr.)	Short-term Expert	06 Jun - 12 Jun 2016

Annex 5-3: South African Researchers' visit to Japan

Name	Sex	Affiliation	Position	Training Institutes	Training Theme	Date of Dispatch	Date of Return	Contents of Training	Duration
Willem A. Landman	Male	CSIR	Chief Researcher	JAMSTEC	Climate veriavility modeling	20141018	20141026	Discussion on the research direction and methods regarding the prediction of climate variability in Southern Africa	9days
Asmerom F.Beraki	Male	SAWS	Researcher	JAMSTEC	Climate veriavility modeling	20141018	20141026	Discussion on the research direction and methods regarding the prediction of climate variability in Southern Africa	9days
Neville Sweijd	Male	ACCESS	Acting Director	NEKKEN, JAMSTEC	Development of early-warning system	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days
Rajendra Maharaj	Male	MRC	Director MRC Office for Malaria Research	NEKKEN, JAMSTEC	Infectious disease epidemic prediction modeling	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days
Angela Mathee	Female	MRC	Director, Environment & Health Research Unit	NEKKEN, JAMSTEC	Infectious disease epidemic prediction modeling	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days
Philippus Kruger	Male	TMI	Senior Manager	NEKKEN, JAMSTEC	Infectious disease epidemic prediction modeling	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days
Peter Wootbooi	Male	UWC	Professor, Department of Math and Applied Math	NEKKEN, JAMSTEC	Infectious disease epidemic prediction modeling	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days
Francois Engelbrecht	Male	CSIR	Researcher, Natural Resources and the Environment	NEKKEN, JAMSTEC	Climate veriavility modeling	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days
Morwamphage Nkadimeng	Male	DOH	Senior General Manager	NEKKEN, JAMSTEC	Infectious disease epidemic prediction modeling	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days
Brilliant Petja	Male	UL	Scientific Manager	NEKKEN, JAMSTEC	Infectious disease epidemic prediction modeling	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days
Modiegi Pertunia Selematsela	Female	DST	Deputy Director: Health Innovation	NEKKEN, JAMSTEC	Development of early-warning system	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days
Gcino Mlaba	Female	DST	Assistant Director, Development partnership	NEKKEN, JAMSTEC	Development of early-warning system	20150124	20150131	Participation and presentation at the project open symposium and Research meeting	8days

Annex 5-4 : Training in Japan

Name	Sex	Organisation	Position	Trainig Site	Trainig Area	Departure Date	Arraival Date	Training Contents	Duration
Aluwani Ramalata	Female	University of Limpopo	Junior Lecturer/ Master Course Student	Nagasaki University, Institute of Tropical Medicine	GIS, Statistical Analysis	2015/11/22	2015/12/13	This training is designed for the GIS experts to refine their visualization skill and to acquire new efficient analytic techniques for the swift analysis and visualization with newly acquiring data among malaria occurrence, climate and environmental elements. In addition to the analytic and visualization exercise, the trainee is expected to lean necessary communication skills for the collaborative research with foreign institutes, such as efficient technique for discussion, reporting, presentation, and thesis drafting.	22 days
Ngoza Thandi Ethel Kapwata	Female	Medical Research Council (Durban)	GIS technologist	Nagasaki University, Institute of Tropical Medicine	GIS, Statistical Analysis	2015/11/22	2015/12/13		22days
Sandile Blessing Ngwenya	Male	University of Venda	Master Course Student	JAMSTEC, Application Laboratory	Data Analysis for correlation among climaic and infectious diseases	2015/11/23	2015/12/13	The principal responsible tasks for the University of Venda in the iDEWS Project are (1) maintenance and management of climatic and infectious diseases data from different sources, and (2) Data Analysis of the correlation among the climatic and infectious diseases, especially analysis for malaria outbreaks. The training was particularly designed for a young researcher who needs to learn essential standards for the international collaborative research with foreign institutes. As the fundamental aspect as the researcher for the iDEWS project, the trainee was expected to acquire the basic knowledge such as research ethics, relevant common regulations based on international agreements, as well as necessary skills like efficient and effective presentation and drafting of papers in limited time. In the technical training, the trainee was expected to broadly understand basic and applied techniques in statistic analysis for the utility of the collected data.	21 days

Annex 5-5 : Training in the Republic of South Africa

Date	Training Name	Venue	Course Summary	Participants
10-11 Sep, 2015	Mapping GIS Training	Tzaneen Malaria Institute	1. Operation Guidance for GIS handheld equipment 2. Software exercise	5 Staff from Tzaneen Malaria Institute 1 Japanese expert
14-16 Sep, 2015	iDEWS Lecture Series	University of Limpopo, Boardroom in main Library	Lectures by Japanese & S.A. experts on 1. Malaria Control in S.A. 2. Climate Predicition 3. Statistic Analysis	40 master/ honor students from universities of Limpopo and Venda
24-27 Apr, 2016	Intensive Statistics & GIS exercise Training	Tzaneen Malaria Institute	Intensive Statistics exercise training by Dr. Takayoshi Ikeda and GIS exercise by Dr. Peter Larson	Ms. Tsundzukani Masesi

5-6　供与機材リスト

Annex 5-6: Provision oif Equipment

Procurement	Items	Qty	Allocation	Arrival Date	Usage Status	Note
Purchased in S.A.	Dissecting Microscope	4	Tzaneen Malaria Institute	20150311	In Use	Olympus SZ51 Microscope, WHSZ10X-H Eyepices, SZ2-ILST-5 illuminator
Purchased in S.A.	Digital Microscope	2	Tzaneen Malaria Institute	20150311	In Use	Dino-Lite Premier Digital Microscope
Purchased in S.A.	Compound Microscope	1	Tzaneen Malaria Institute	20150311	In Use	Olympus CX22 LED Microscope
Purchased in S.A.	Agarose gel electrophoresis chambers	2	Tzaneen Malaria Institute	20150225	In Use	Enduro 20.20 Horizontal Gel Box E1020-20
Purchased in S.A.	Power supplies For electrophoresis	3	Tzaneen Malaria Institute	20150225	In Use	Euduro 250 volt power supply E0203-230V
Purchased in S.A.	pH meter	1	Tzaneen Malaria Institute	20150216	In Use	Consort, C5010 ph/EC/mV/Temp/DO meter (1 set), General purpose glass bodied electrode P11, Temperature electrode for Automatic temp comensation, Swing-arm electrode stand, Buffer 4, 7m 10 solutions 500ml
Purchased in S.A.	Pipette Sets	10	Tzaneen Malaria Institute	20150316	In Use	Nichiryo Co., Ltd, EXII micropipette (0.1-2ul, 2-20ul, 10-100ul, 20-200ul, 100-1000ul, 5 pieces respectively)
Purchased in S.A.	Water purifier	1	Tzaneen Malaria Institute	20150305	In Use	Heal Force Bio-Meditech Holdings Limited, Smart-N Water Ultra purification VF type (1 set)
Purchased in S.A.	Vortex shaker	1	Tzaneen Malaria Institute	20150305	In Use	Inter Bio-Lab, Inc.Vortex Mixer VM 300 (1 set)
Purchased in S.A.	Weighing balance	1	Tzaneen Malaria Institute	20150305	In Use	Adam Equipment, PGW753i (1 set)
Purchased in S.A.	Environmental test chamber	1	Tzaneen Malaria Institute	20150305	In Use	Pol-Eko Measurement Laboratory, K 350 Top+INOX (1 set)
Purchased in S.A.	ArcGIS Software	1	Tzaneen Malaria Institute	20150305	In Use	Esri South Africa, ArcGIS for Desktop Basic Single Use (1 license), ArcGIS for Desktop Spatial Analyst (1 license)
Purchased in S.A.	MATLAB Software	1	University of Pretoria	20150320	In Use	Mathworks Pty. Ltd, MATLAB (Individual) (1 license), Statistics Toolbox (Individual) (1 license)
Purchased in S.A.	Portable Turbidity meter	2	Medical Research Council (JHB)	20150311	In Use	HACH, 2100Q Portable Turbidimeter (2 sets)
Purchased in S.A.	Portable Multiple meter (pH, Conductivity, Temperture)	2	Medical Research Council (JHB)	20150311	In Use	HACH, HQ40d Portable pH, Conductivity, Optical Dissolved Oxgen (DO), ORP, and ISE Multi-Parameter Meter (2 sets), Probe (1 m IntCal pH, Conductivity, Dissolved Oxygen, 2 sets)
Purchased in S.A.	Colorimeter (Chlorine, Free and Total, pH)	3	Medical Research Council (JHB)	20150311	In Use	Hach Pocket Colorimeter II Chlorine (Free and Total) plus pH (3 sets)
Purchased in S.A.	Portable Flourimeter	2	Medical Research Council (JHB)	20150311	In Use	ANDalyze, AND1100 Handheald Flourimeter (2 sets)
Purchased in S.A.	DPD Free Chlorine Reagent Dispenser	2	Medical Research Council (JHB)	20150311	In Use	HACH, DPD Free Chlorine Reagent SwiftTest Dispenser (3 sets)
Purchased in S.A.	Mobile fridge	4	Medical Research Council (JHB)	20150313	In Use	Campmaster Fridge Freezer 40L Thermo (4 sets)
Purchased in S.A.	Temperature data loggers	400	Medical Research Council (JHB)	20150311	In Use	LogTag Recorders Ltd, HAX08 LogTagTemperature / RH Recorder (400 sets), LogTag Interface Cradle (1 set)
Purchased in S.A.	Dust Track II Desktop model	2	Medical Research Council (JHB)	20150311	In Use	Dust Track II Desktop Model 8530 (3 sets)
Purchased in S.A.	Indoor Air Quality Meters (CO2, CO, Temperature, Humidity)	3	Medical Research Council (JHB)	20150311	In Use	TSI Incorporated, IAQ-CALC Indoor Air Quality Meters Model 7545
Purchased in S.A.	CO Passive badge	200	Medical Research Council (JHB)	20150311	In Use	Morphix Technologies. ChromAir Passive Badge-Carbon Monoxide 380008-10 (10 sheets / pack, 200 packs)
Purchased in S.A.	Micro + smokerlyzer (CO Breath Testing Machine)	6	Medical Research Council (JHB)	20150311	In Use	Bedfont Scientific. Ltd, Micro + smokerlyzer Unit Complete (6 sets)
Purchased in S.A.	Hemoacue Hb 201+ Analyser	3	Medical Research Council (JHB)	20150312	In Use	HemoCue, Hb 201 DM System (3 sets)
Purchased in S.A.	Infrared tympanic themometer	8	Medical Research Council (JHB)	20150311	In Use	Braun TermoScan Model 4020 (8 sets)
Purchased in S.A.	Lancing device with Glucose Monitor	8	Medical Research Council (JHB)	20150128	In Use	ACC-Check Active Glucose Monitor (8 sets)
Purchased in S.A.	Electric Weight Scales	6	Medical Research Council (JHB)	20150313	In Use	SECA 813 Digital Flat Scale (6 sets)

Purchased in S.A.	Height measurement device	6	Medical Research Council (JHB)	20150313	In Use	SECA 213 Portable Height Measurement (6 sets)
Purchased in S.A.	Data entry/collection tablet	8	Medical Research Council (JHB)	20150302	In Use	Samsung Galaxy Note 3 (8 sets)
Purchased in S.A.	Gazebo for field survey	2	Medical Research Council (JHB)	20150224	In Use	Campmaster Gazebo (2 sets)
Purchased in S.A.	Camping Stool for field survey	8	Medical Research Council (JHB)	20150224	In Use	OUT & ABOUT, Camping Stool (8 sets)
Purchased in S.A.	CDC Miniature Light Trap	10	Tzaneen Malaria Institute	20150527	In Use	CDC Miniature Light Trap Model 512, 4D-Cell External Battery Holders
Purchased in S.A.	Notebook PC for analysis	1	Tzaneen Malaria Institute	20150601	In Use	Lenovo 15.6Idea Pad Core i7 Notebook (1set)
Purchased in S.A.	Desktop PC for analysis (with extra 2 Terabyte HDD)	1	University of Pretoria	20150709	In Use	DELL Precision T1700 Mini Tower (1 set), Hard Drove 2 TB 3.5 inch Serial
Purchased in S.A.	Notebook PC for analysis (with external CD-RW+DVD-RW)	1	Tzaneen Malaria Institute	20150715	In Use	ACEW TMP645-S I7-5500U 14" (1 set), USB 2.0 SLIM CD-RW+DVD-RW (1
Purchased in S.A.	Desktop PC for analysis	1	Tzaneen Malaria Institute	20150715	In Use	Lenovo Thinkcenter Edge E93z AIO Touch i7 Desktop (10BA0050SA) (1 set)
Purchased in S.A.	A4 size Color Laser Printer	1	Tzaneen Malaria Institute	20150715	In Use	Hewlett Packard Color Laser Jet CP5225N (1 set)
Purchased in S.A.	Automatic Weather Station	5	Applied Centre for Climate and	20150720	In Use	Davis Instruments Pty. Ltd. Wireless Vantage Pro2 Weather Station (5 sets)
Purchased in S.A.	Notebook PC for analysis (with Microsoft Office Software)	1	University of Limopopo	20150723	In Use	Hewlett Packard Elitebook850 G2 (1 set), Microsoft Office Home and Business 2013 (1 set)
Purchased in S.A.	Mapping GIS Device (With Charging kit, Software for	8	Tzaneen Malaria Institute	20150911	In Use	Trimble Juno 3B Handheld (8 sets), Trible Recon Handheld 12V Vehicle
Purchased in S.A.	Roopamp Realtime Turbidimeter	1	National Institute of Communicable	20150921	In Use	Eiken Chemical Co. Ltd, Loopamp Realtime Turbidimeter LA-500
Purchased in S.A.	CDC Miniature Light Trap (with Battery Holder, New	50	Tzaneen Malaria Institute	20150925	In Use	CDC Miniature Light Trap Model 512 (50 sets), 4D-Cell External Battery
Purchased in JPN	Incubator	1	Tzaneen Malaria Institute	20160329	In Use	Eiken Chemical Co. Ltd Incubator LF-160
Purchased in JPN	Loopamp Malaria Pan Detection Kit	1	Tzaneen Malaria Institute	20160107	In Use	Eiken Chemical Co. Ltd, LMC561 Loopamp Malaria Pan Detection Kit
Purchased in JPN	Loopamp Malaria Pan/Pf Detection Kit	2	Tzaneen Malaria Institute	20160107	In Use	Eiken Chemical Co. Ltd, LMC562 Loopamp Malaria Pan/Pf Detection Kit
Purchased in JPN	Loopamp Pure DNA Extraction Kit	6	Tzaneen Malaria Institute	20160107	In Use	Eiken Chemical Co. Ltd, LMC802 Loopamp Pure DNA Extraction Kit (90
Purchased in S.A.	Note Book PC	3	South Africa Medical Research	20160224	In Use	Hewlett Packard Elitebook850 G2
Purchased in JPN	Loopamp Malaria Pan Detection Kit	3	Tzaneen Malaria Institute	20160329	In Use	Eiken Chemical Co. Ltd, LMC561 Loopamp Malaria Pan Detection Kit
Purchased in JPN	Loopamp Malaria Pan/Pf Detection Kit	3	Tzaneen Malaria Institute	20160329	In Use	Eiken Chemical Co. Ltd, LMC562 Loopamp Malaria Pan/Pf Detection Kit
Purchased in JPN	Loopamp Pure DNA Extraction Kit	15	Tzaneen Malaria Institute	20160329	In Use	Eiken Chemical Co. Ltd, LMC802 Loopamp Pure DNA Extraction Kit (90
Purchased in JPN	Loopamp Malaria Pan/Pf Detection Kit	10	National Institute of Communicable	20160329	In Use	Eiken Chemical Co. Ltd, LMC562 Loopamp Malaria Pan/Pf Detection Kit
Purchased in S.A.	Overhead Document Scanner	1	South Africa Medical Research	20160415	In Use	Fujitsu Scansnap SV600

別添 6. PDM version 2（2016 年 10 月 4 日）

Project Design Matrix (PDM) (Version 2)

Date: October 4, 2016

Project Title: The Project for Establishment of an early-warning system for infectious diseases in southern Africa incorporating climate predictions

Project Duration: 5 years from May 12, 2014 to May 11, 2019

Target Area: The Limpopo Province of the Republic of South Africa

Project Administration:

Project Director: Chief Director, Biotechnology, Department of Science and Technology (DST)

Project Co-Director: Chief Director, Communicable Diseases, National Department of Health (NDOH)

Target Group :

Direct Beneficiaries: a total of 46 researchers (1 from the Applied Centre for Climate and Earth Systems Science (ACCESS); 12 from the South African Medical Research Council (MRC), 6 from the Council for Scientific and Industrial Research (CSIR); 2 from the National Institute for Communicable Diseases (NICD); 6 from the South African Weather Service (SAWS); 1 from the Limpopo Department of Health (LDOH); 2 from the Limpopo Department of Health-Malaria Control (LDOH-Malaria); 3 from the University of Cape Town (UCT); 4 from the University of Venda (UV); 4 from the University of Limpopo (UL); 2 from the University of Pretoria; and 2 from the University of the Western Cape (UWC))

Indirect Beneficiaries: Residents in the Limpopo Province: 5.4 million

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Project Purpose			
A climate-based early-warning system model for infectious diseases control is established as a precursor for further application across southern Africa.	(1) The iDEWS, the installation guide, the operational guidelines, operational costs, etc. are packaged as a precursor model for disseminating to other areas by the end of the project period. (2) The iDEWS is presented to relevant South African authorities as a tool by the end of the project period.	(1) Official report that represent the presentation of iDEWS to the relevant authorities (2) Project report(s)	
Outputs			
1 **Climate-based infectious disease epidemic prediction models are developed especially for malaria, pneumonia and diarrhoea.**	(1) The iDEWS is developed with the prediction performance of a likelihood of malaria outbreaks with 3-month leadtime. The likelihood will be based on a verification of at least 60% agreement between retrospective prediction and past observations of defined outbreaks by the time of the Terminal Evaluation. (2) The pneumonia prediction is prepared for potential use in early warning with 3-month leadtime. The prediction of seasonal variation will be based on a verification of at least 60% agreement between retrospective prediction and past observations by the time of the Terminal Evaluation. (3) The diarrhoea prediction is prepared for potential use in early warning with 3-month leadtime. The prediction of seasonal variation will be based on a verification of at least 60% agreement between retrospective prediction and past observations by the time of the Terminal Evaluation. (4) More than 4 research papers first and/or co-authored by both Japan and South Africa collaborators related to iDEWS, infectious disease mathematical and statistical models, short-term climate variability prediction system, relationship	(1) Scientific research articles in reputed international journals (2) Project report(s) (3) Letter of acknowledgement from respective authorities	
2 **Operational guidelines of the climate prediction-based infectious diseases early warning system (iDEWS) are developed in the Limpopo Province.**	(1) The preparatory committee for iDEWS operation is launched at the Limpopo Province by the time of the Mid-term Review. (2) The iDEWS operational guidelines is considered by	(1) Project report (2) iDEWS operational guidelines	
3 **Prediction performance and operability of the iDEWS are verified.**	(1) Prediction performance and operability of the iDEWS are evaluated by a pilot application at the Limpopo Province by May 2018. (2) Adaptability of the iDEWS to other areas including other provinces and neighbouring countries is presented to appropriate authorities by February 2019.	(1) Project reports (2) Meeting minutes with approproate authorities	
Activities	**Inputs**		
1 **Climate-based infectious disease epidemic prediction models are developed especially for malaria, pneumonia and diarrhoea.**	**Japan**	**South Africa**	Necessary cooperation is gained by external project supporters (e.g. ARC and superintendents of public buildings, etc.) for the project activities.
1-1. Prospective and retrospective data/information acquisition systems are developed in the areas of infectious diseases and climate variability	**(1) Chief Advisor;** **(2) Project Coordinator;** **(3) Other Experts in Epidemiology, Medical Entomology, Climate Dynamics, Public Health and other necesarry areas;** **(4) Training in Japan for Climate Disease Modeling;** **(5) Necessary equipment for research and development activities; and** **(6) Running expenses necessary for implementation of the project activities other than that borne by the South African side.**	**(1) Research Scientists in Epidemiology, Medical Entomology, Climate Dynamics and other related areas;** **(2) Research Staff and Laboratory Technicians;** **(3) Office space at ACCESS, UL and DOHL-Malaria;** **(4) Laboratory space at DOHL-Malaria;** **(5) Existing Equipment at MRC, CSIR, UL and DOHL-Malaria;** **(6) Available data, information and specimens related to the project; and** **(7) Support to the project activities will be made available in accordance with the laws and regulations in force in South Africa, and subject to the availability of resources.**	
1-1-1. To develop databases of data/information of malaria, pneumonia and diarrhoea respectively from local health information system, archival records of health facilities and so on.			
1-1-2. To determine investigation target sites on the basis of a risk map for respective diseases, which is developed using retrospective data from the database.			
1-1-3. To conduct fact-finding surveys at communities in the targeted sites with regard to incidence and prevalence of respective diseases (including undiagnosed diseases), residents' behaviour that impacts on the prevalence (health seeking behaviour, etc.) and hygienic environment (water quality, air pollution, malaria mosquito insecticide resistance etc.), followed by populating the data into			
1-1-4. To source climatic and non-climatic ancillary environmental data (geographic data, etc.) from ACCESS partner organizations such as the South African Weather Service (SAWS) and the Agricultural Research Council (ARC).			
1-1-5. To observe local-scale meteorological data in the target sites by placing basic observation stations at public buildings.			
1-2. Elucidation of relationships among incidence/prevalence of the target diseases and climate variability (ambient temperature, humidity, precipitation, etc.).			
1-2-1. To investigate the relationship between incidence/prevalence of the target diseases and climate variability using time-series analysis			
1-2-2. To investigate the relationships of proliferation of malaria vectors with climate variability and malaria incidence/prevalence.			
1-2-3. To investigate the relationship between regional-scale climate variations in the Limpopo Province and their links with the global climate phenomena such as the El Nino Southern Oscillation (ENSO), the Indian Ocean Dipole Mode (IODM) and the Sub-tropical Dipole Mode (SDM).			

1-3.	Development of infectious disease mathematical and/or statistical models for malaria, and statistical models for pneumonia and diarrhoea of which local epidemic situation is reflected			
	1-3-1. To review existing infectious disease models (related to climate in particular) for malaria, cholera, and pneumonia.			
	1-3-2. To develop basic mathematical and/or statistical models for malaria, and statistical models for pneumonia and diarrhoea by modifying existing model(s) or newly developing.			
	1-3-3. To calibrate the models by verifying their prediction performance using retrospective and prospective data/information of infectious diseases obtained from the database.			
1-4.	Improvement of a seasonal prediction system based on an ocean-atmosphere coupled general circulation model (CGCM) called SINTEX-F; improving its skill, downscaling, extending its lead-time			
	1-4-1. To improve the prediction accuracy of SINTEX-F for the short-term seasonal climate variability by enhancing model resolution, implementing better physics and data assimilation in next versions of SINTEX-F on the Earth Simulator.			
	1-4-2. To reduce model biases by model validations and intercomparisons among SINTEX-F1, new SINTEX-F2 and other climate models developed in South Africa.			
	1-4-3. To improve resolution and lead time for climate prediction of the SINTEX-F for better local-scale prediction performance by using a dynamical downscaling model such as Weather Research and Forecasting model (WRF) and statistical downscaling techniques.			
	1-4-4. Interactively with the Activity 1-4-3, to fine-tune WRF downscaling model using local data available from the weather and climate observations at the target areas (Activity 1-1).			
1-5.	Development of the climate-based infectious disease prediction models for malaria, pneumonia and diarrhorea			
	1-5-1. To develop a climate-based infectious disease epidemic prediction models for malaria, pneumonia and diarrhoea by coupling the infectious disease mathematical and statistical models and the adopted climate prediction model, in light of the relationships among incidence/prevalence of the target diseases, climate variability and proliferation of vectors (Activity 1-2).			
	1-5-2. To calibrate the models by verifying their prediction performance using existing data/information of infectious diseases epidemics and outbreaks obtained from the database.			
2	**Operational guidelines of the climate prediction-based infectious diseases early warning system (iDEWS) are developed in the Limpopo Province.**			
	2-1. To launch a preparatory committee for introducing the iDEWS at the Limpopo Province consisting of organizations responsible for epidemic prediction, issuing epidemic/alerting information and implementing countermeasures based on such information.			
	2-2. To set criteria for outbreak alerting.			
	2-3. To set communication flow of infectious diseases epidemic/outbreak information in the Limpopo Province.			
	2-4. To develop an iDEWS operational Guidelines comprising regular reporting of epidemics, issuing outbreak alerting and consequent countermeasures, organogram of iDEWS operation, formats of regular reporting and alerting, etc.			
3	**Prediction performance and operability of the iDEWS are verified.**			
	3-1. To evaluate the prediction performance and operability of the iDEWS through a pilot application at the Limpopo Province.			
	3-2. To conduct table-top exercises regarding issuing outbreak alerting and consequent countermeasures at the Limpopo Province.			
	3-3. To develop a sustainable monitoring and evaluation system for assessing impacts of the iDEWS on infection control at the Limpopo Province.			**Pre-conditions**
	3-4. To verify the applicability of other areas using available data of epidemics, climate and non-climate environment at other provinces of the South Africa and neighbouring countries.			1. Research permissions are obtained by the relevant authority/-ies of South Africa where necessary.
	3-5. To hold workshop(s) geared to administrative officers, researchers, etc. in the areas of climate variability and infection control from the government of the South Africa and neighbouring countries for the deployment of iDEWS.			2. Approvals are obtained for medical researches and related interventions/investigations by the ethical committees of the Institute of Tropical Medicine, the Nagasaki University, MRC and other related organization to the project activities.
	3-6. To start discussions with administrative officers, researchers, etc. in the areas of climate variability and infection control of the government of the South Africa for the dissemination of iDEWS.			


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