



SAHF CLIMATE SERVICES PROJECT

Regional Capacity Development Framework for Climate Services in South Asia

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EXECUTIVE SUMMARY

The **Regional Capacity Development Framework for Climate Services in South Asia** provides a common architecture for planning, coordinating, delivering, and sustaining capacity development across the region. Developed under the South Asia Hydromet Forum (SAHF) Climate Services Project, with support from the UK Government's Foreign, Commonwealth and Development Office (FCDO) through the Weather and Climate Information Services (WISER) under the Climate Action for a Resilient Asia (CARA), the Framework responds to the need to move beyond isolated training events towards a coordinated, progressive, and user-oriented regional capacity-development system. It is informed by a regional Training Needs Assessment (TNA) involving National Meteorological and Hydrological Service personnel and representatives from climate-sensitive user sectors in South Asia, together with consultations with the SAHF Climate Services Working Group.

The assessment identified established regional strengths in climate monitoring, seasonal forecasting, regional technical exchange, and the application of climate information in agriculture, disaster risk reduction, water resources, health, infrastructure, humanitarian action, and adaptation planning. However, priority gaps remain in climate-data management and quality control; sub-seasonal-to-seasonal forecasting; model interpretation; downscaling and bias correction; forecast verification; long-term climate information; information and communications technology competencies; decision-support systems; impact-based forecasting; uncertainty communication; co-production; standard operating procedures; National Frameworks for Climate Services; monitoring and evaluation; and resource mobilization. User-sector institutions also require stronger capacity to interpret probabilistic information, assess sectoral risks, identify thresholds and decision points, and translate climate information into preparedness, early action, adaptation, and operational decisions.

The Framework links these needs through five interconnected elements:

- differentiated learning pathways for climate service producers, user sector institutions, producer–user groups, trainers, and institutional leaders;
- four competency pillars covering climate data and forecast production; sectoral application, thresholds, and early action; communication, dissemination, and co-production; and institutionalization, and sustainability;
- blended delivery mechanisms, including regional technical training, producer–user workshops, Training-of-Trainers, mentoring, technical clinics, peer exchange, exposure visits, and SAHF Knowledge Hub-based learning;
- institutionalization and regional coordination through SAHF, NMHSs, Regional Climate Centres, training institutions, technical partners, user sectors, and related Working Groups; and
- cross-cutting Monitoring, Evaluation, and Learning (MEL); Gender Equality, Disability, and Social Inclusion (GEDSI); and sustainability.

Implementation is proposed over an indicative 24–36-month period. Phase 1 will validate the Framework, prioritize competency areas, identify participant pathways and training partners, establish the Training-of-Trainers pool, and prepare the initial implementation calendar. Phase 2 will deliver core producer and user-sector competencies. Phase 3 will apply learning through thresholds, advisories, trigger-action matrices, SOPs, decision-support workflows, NFCS materials, and CSUF- and NCOF-linked processes. Phase 4 will focus on institutionalization,

national cascading, peer learning, resource mobilization, and continuation of regional learning mechanisms. Training-of-Trainers will operate as a cross-cutting track throughout these phases.

Monitoring will extend beyond participation and course completion to assess competency improvement, operational application, institutional uptake, producer–user engagement, knowledge transfer, and sustainability. Training priorities will be reviewed periodically in response to implementation experience, emerging country needs, new tools and datasets, and MEL findings.

The Framework ultimately seeks to strengthen the capacity of South Asian institutions to produce, communicate, interpret, and apply reliable, localized, accessible, actionable, and inclusive climate information. Its intended result is a sustained regional system in which individual learning is translated into improved products, operational workflows, institutional practice, stronger provider–user collaboration, and climate-informed preparedness, early action, adaptation, planning, and resilient development.

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1 INTRODUCTION

1.1 Background and Regional Context

South Asia is among the most climate-vulnerable regions globally, facing intensifying impacts from climate variability and long-term climate change. The increasing frequency and severity of extreme events—including heatwaves, floods, droughts, and tropical cyclones—are placing significant pressure on socio-economic systems and development gains. Recent events highlight this trend, including extreme heat in India exceeding 50°C, catastrophic flooding in Nepal, and widespread impacts from Tropical Cyclone Remal across Bangladesh and eastern India, alongside recurring cold spells, droughts, and flash floods in Afghanistan and Pakistan (WMO, 2024). These hazards are further compounded by high exposure and vulnerability, with over two billion people in the region—many living in poverty—facing limited adaptive capacity (OPHI, 2024; IPCC, 2022).

In this context, climate services (CS) are critical for enabling proactive climate risk management by transforming climate data into actionable information for decision-making. Effective climate services span multiple timescales—from weather forecasts to seasonal outlooks and long-term projections—and support key sectors such as agriculture, water, health, energy, and disaster risk reduction. However, the transition from generating climate information to delivering user-oriented, decision-relevant services remains a key challenge across the region.

The World Meteorological Organization (WMO) Global Framework for Climate Services (GFCS) provides the principal international framework for strengthening the production, delivery, and use of climate information. It is organized around five interrelated pillars:

1. observations and monitoring;
2. research, modelling, and prediction;
3. climate services information systems;
4. user interface platforms; and
5. capacity development.

In South Asia, regional coordination mechanisms such as the South Asia Hydromet Forum play a central role in operationalizing these pillars by fostering collaboration among National Meteorological and Hydrological Services (NMHSs) and regional partners.

Under this framework, the SAHF Climate Services Working Group (CS WG), established in 2025 with technical support from the UK Met Office, has developed a regional work plan to strengthen climate service delivery. Key regional platforms—including the South Asian Climate Outlook Forum (SASCOF) and the Climate Services User Forum (CSUF)—support this effort by enhancing forecasting capacity and facilitating producer–user engagement. These mechanisms contribute to improved production and dissemination of climate information, particularly at seasonal and sub-seasonal timescales.

Despite these advances, significant gaps remain across GFCS pillars. These include uneven observational coverage and data management systems, limited integration of modelling outputs into operational services, challenges in tailoring climate information to sector-specific decision contexts, and insufficient institutional and human capacity to sustain service delivery. Notably, the State of Climate Services 2024 report emphasizes that capacity development

remains a persistent bottleneck, particularly in translating technical capabilities into operational, user-oriented services (WMO, 2024).

To address these challenges, the SAHF Climate Services Project conducted a Training Needs Assessment (TNA) to systematically identify capacity gaps across NMHSs and key stakeholders. The TNA applied a structured analytical framework aligned with GFCS pillars and complementary dimensions, including stakeholder engagement, data and technological capabilities, institutional capacity, and governance and sustainability. The assessment highlighted priority needs in areas such as climate data management and analysis, forecast interpretation across timescales, impact-based forecasting, communication of uncertainty, co-production with users, and the development of decision-support services.

Consultations with the SAHF Climate Services Working Group further identified priority topics including IT-related competencies, data quality management and handling, development and use of gridded observation datasets, threshold development, downscaling and bias correction, use and interpretation of NWP model outputs, and forecast interpretation and translation for user sectors. The role of SASCOF and CSUF were also recognized as vital mechanisms for targeted learning and producer-user engagement, but emphasized the need for a periodic and sustained capacity building activities beyond these forums.

Given the diversity of capacities, institutional arrangements, and user needs across South Asia, capacity development for climate services requires a coordinated regional framework rather than isolated training events. This Framework responds to that need by setting out a structured approach for periodic learning, competency development, regional cooperation, and institutionalization of climate services capacities across NMHSs and user sector institutions.

1.2 Evidence Base and Rationale for the Framework

The Regional Capacity Development Framework is informed principally by the TNA conducted under the SAHF Climate Services Project and by subsequent consultations with the SAHF Climate Services Working Group. The TNA assessed both the production and use of climate services across South Asia and established an indicative regional baseline of technical, operational, institutional, and user capacities.

The NMHS component examined capacities related to climate monitoring, data management, forecasting and modelling across timescales, climate-service production and dissemination, decision-support systems, user engagement, institutional governance, training delivery, and sustainability. The user sector component assessed how climate information is accessed, understood, interpreted, and applied in planning, preparedness, early action, adaptation, and operational decision-making.

The assessment included responses from 33 NMHS personnel representing nine South Asian countries and 29 professionals from climate-sensitive user sectors. Although the sample was unevenly distributed across countries and sectors and relied on self-assessed capacities, it provides a useful regional baseline for identifying shared priorities and areas requiring more detailed country-level assessment.

The TNA identified several existing **strengths**:

- NMHSs have an important foundation of experienced personnel and comparatively established capability in climate monitoring and seasonal forecasting.
- Regional processes such as SASCOF have supported seasonal forecast production, regional technical exchange, and the interpretation of regional climate conditions.
- User sector institutions are already applying climate information in agriculture, disaster risk management, water resources, health, infrastructure, humanitarian action, adaptation planning, and other operational and strategic contexts.

However, capacities remain uneven across countries, institutions, technical functions, and sectors. **Priority capacity needs identified among NMHSs include:**

- sub-seasonal-to-seasonal forecasting and interpretation of multi-model ensemble products
- forecast verification and evaluation of forecast skill
- downscaling, post-processing, calibration, and bias correction
- climate modelling and interpretation of global and regional model outputs
- decadal and long-term climate-information analysis
- statistical methods, Python-based processing, automation, and appropriate applications of artificial intelligence and machine learning
- climate-data management, quality control, metadata, archiving, and integration of observational and model datasets
- development and operational use of decision-support systems and climate-information platforms
- impact-based forecasting and development of risk-informed and sector-specific advisories
- communication of probability, uncertainty, forecast skill, confidence, and limitations
- co-production of climate services with user sectors
- standard operating procedures (SOPs), feedback mechanisms, monitoring and evaluation, National Frameworks for Climate Services (NFCS), project development, and climate finance
- observational, ICT, data-processing, and computational infrastructure

User sector respondents generally reported basic to moderate familiarity with commonly used climate terminology and products. Understanding was less consistent for probabilistic forecasts, climate drivers, verification, attribution, climate models, scenarios, and long-term projections. Respondents also indicated that access to climate information did not always lead to its effective application, particularly when information was insufficiently localized, sectoral implications were unclear, or institutional decision procedures and guidance were absent.

Priority capacity needs among user sectors include:

- interpretation of seasonal outlooks, probabilistic forecasts, and climate advisories
- understanding of forecast uncertainty, confidence, skill, and limitations
- application of impact-based forecasting concepts
- sector-specific climate-risk analysis
- translation of forecasts into preparedness, early action, contingency planning, and operational decisions
- communication of climate risks within institutions and communities

- use of long-term climate information for adaptation, infrastructure, and strategic planning
- use of relevant decision-support systems
- stronger engagement and co-production with NMHSs

Table 1. Summary Alignment of TNA Findings with the Framework

Consolidated TNA finding	Framework response	Intended result
Uneven technical capacity across climate timescales	Progressive producer training on data, forecasting, modelling, verification, and localization.	Improved and more reliable climate products.
Limited interpretation and sectoral application	User-sector and producer–user learning focused on risks, thresholds, decisions, and early action.	More usable climate information and climate-informed decisions.
Weak communication and provider–user engagement	Strengthened co-production, dissemination, feedback, CSUF, and NCOF processes.	More relevant and accessible climate services.
Uneven institutional systems and sustainability	Support for SOPs, NFCS processes, leadership, ToT, knowledge transfer, and resource mobilization.	Capacities embedded in institutional practice.
Training constrained by infrastructure and resources	Link learning with technical assistance, data and ICT systems, staffing, partnerships, and financing.	Improved application and sustainability of competencies.

The regional synthesis demonstrates that provider and user needs are interdependent. Demand for more localized information requires stronger NMHS capacity in downscaling, post-processing, model calibration, verification, and integration of local observations. Improved interpretation by users requires clearer communication of probability, uncertainty, forecast skill, and limitations. Translation of forecasts into early action requires both NMHS capacity to develop impact-based and risk-informed advisories and user sector capacity to connect forecasts with thresholds, decision calendars, contingency plans, and operational procedures.

Consultations with the Climate Services Working Group reinforced these findings and identified complementary priorities, including:

- climate-data quality management, development and validation of gridded observation datasets
- integration of satellite and ground observations
- interpretation of numerical weather prediction and climate-model outputs
- threshold development
- IT competencies for meteorologists
- forecast dissemination
- support to NFCS development/implementation
- institutionalization through SOPs and operational workflows

Collectively, these findings show that capacity development cannot be addressed through isolated or one-off training events. Improvements in forecasting will have limited effect unless climate information is localized, communicated clearly, connected to sectoral decisions, and supported by institutional systems. Similarly, user training will have limited impact unless NMHSs have the data, tools, infrastructure, procedures, and engagement mechanisms required to provide reliable and actionable climate services.

1.3 Purpose and Scope of the Framework

The Regional Capacity Development Framework provides a common architecture for planning, coordinating, delivering, and sustaining climate-services capacity development across South Asia. It is intended to guide the SAHF Climate Services Working Group, NMHSs, Regional Climate Centres, WMO Regional Training Centres, user sector institutions, universities, technical partners, and development organizations in designing coordinated and demand-responsive capacity development activities.

The Framework covers the full climate services value chain:

- observation, climate-data management, and quality assurance
- modelling, forecasting, downscaling, verification, and product generation
- decision-support systems and operational platforms
- interpretation and communication of climate information
- impact-based forecasting, sectoral application, thresholds, and early action
- provider–user engagement, co-production, and feedback
- SOPs, institutional workflows, NFCS-related coordination, and governance
- project design, climate finance, monitoring, evaluation, and sustainability
- training delivery, knowledge transfer, and institutional learning

The Framework is not intended to prescribe a fixed curriculum or a single regional training programme. It provides a flexible regional structure that can be adapted according to country priorities, institutional mandates, participant roles, existing competency levels, sector requirements, available resources, and operational calendars.

It establishes differentiated development pathways for:

- climate service producers
- user sector institutions
- producer–user co-production groups
- trainers and regional or national resource persons
- institutional leaders/planners, managers, and coordination focal points

Different competencies require different forms of learning and technical support. Delivery may therefore include regional and national in-person training, hands-on forecasting laboratories, virtual and hybrid courses, self-paced learning through the SAHF Knowledge Hub, producer–user workshops, technical clinics, mentoring, staff exchanges, embedded placements, exposure visits, Training-of-Trainers, national cascading, and post-training technical backstopping.

Existing mechanisms such as SASCOF, CSUF, National Climate Outlook Forums, SAHF Working Group activities, and Regional Climate Centre programmes provide important

opportunities for implementation. However, the Framework also responds to the need for periodic and sustained capacity development beyond these events.

The intended result is a regional capacity development system that connects learning with operational application. Capacity-development activities should contribute not only to increased knowledge but also to practical and institutional outputs, including datasets, scripts, quality-control procedures, forecast products, verification workflows, sectoral advisories, threshold matrices, decision calendars, SOPs, decision-support workflows, NFCS support materials, training modules, and institutional action plans.

Through this approach, the Framework seeks to strengthen individual competence, institutional capability, regional cooperation, provider–user collaboration, and the sustained production, delivery, interpretation, and application of climate services across South Asia.

2 GOALS AND OBJECTIVES

The goal of the Regional Capacity Development Framework for Climate Services in South Asia is to establish a sustained, coordinated, and user-oriented system for strengthening and institutionalizing the capacities required to produce, communicate, interpret, and apply climate information across the region.

The Framework seeks to support NMHSs, Regional Climate Centres, user sector institutions, training institutions, and technical partners in progressively developing the knowledge, skills, tools, operational processes, institutional arrangements, and partnerships required to deliver climate services across sub-seasonal, seasonal, decadal, and long-term climate timescales.

By moving beyond isolated training events, the Framework aims to connect individual learning with operational application, institutional uptake, provider–user collaboration, regional technical cooperation, and continued knowledge transfer. Its intended contribution is more reliable, localized, accessible, actionable, inclusive, and sustainable climate services that support preparedness, early action, adaptation, planning, and climate-resilient development across South Asia.

The Framework aims to:

- a. **Establish a sustained regional capacity development mechanism for climate services.** Explore and support periodic, progressive, and demand-driven capacity building through SAHF, RCCs, WMO Regional Training Centres, SASCOF, CSUF, NMHSs, and regional technical partners, moving beyond one-off pre-COF trainings.
- b. **Strengthen and institutionalize core climate services competencies within NMHSs.** Build technical capacity in climate data management, quality control, gridded datasets, S2S and seasonal forecasting, NWP and climate model interpretation, downscaling, bias correction, attribution, IT skills, and climate information dissemination.
- c. **Integrate producer and user capacity development across the climate services value chain.** Strengthen producer–user collaboration by linking technical training for NMHSs with user sector training on forecast interpretation, uncertainty, thresholds, advisories, decision calendars, and translation of climate information into sectoral action. This will be derived from the assessment of existing use of climate information across different sectors, the level of awareness and potential applications to support climate risk informed decision making.
- d. **Support operationalization of priority climate services processes and products.** Enable the development and application of thresholds, trigger-action matrices, sectoral advisories, SOPs, DSS workflows, NFCS support packages, data-sharing mechanisms, and CSUF-linked producer–user translation cycles.
- e. **Ensure sustainability beyond the project-based timelines.** Promote Training-of-Trainers, national cascading, SKHub-based learning, technical clinics, mentoring, exposure visits, country-to-country learning, and continued RCC-led support to institutionalize products, capacities, and workflows.

Through this initiative, the project aims to strengthen and diversify participation in SASCOF and CSUF, ensuring broader engagement of stakeholders from key sectors including agriculture, disaster risk reduction, energy, health, water resources, government agencies, NGOs, academia, media, industry, and civil society.

Structured dialogue and feedback mechanisms within these forums will help NMHSs and regional institutions better align climate services with user needs, strengthening the relevance, usability, and impact of climate information for decision-making across South Asia.

3 FRAMEWORK ARCHITECTURE

The Regional Capacity Development Framework is designed as an integrated architecture for strengthening climate services across South Asia. It connects individual competency development with operational application, institutional strengthening, regional coordination, and sustained learning. The Framework is organized around five interrelated elements, as illustrated in Figure 1. Together, these elements define who requires capacity development, what competencies should be strengthened, how learning will be delivered, how capacities will be institutionalized, and how progress and sustainability will be assessed.

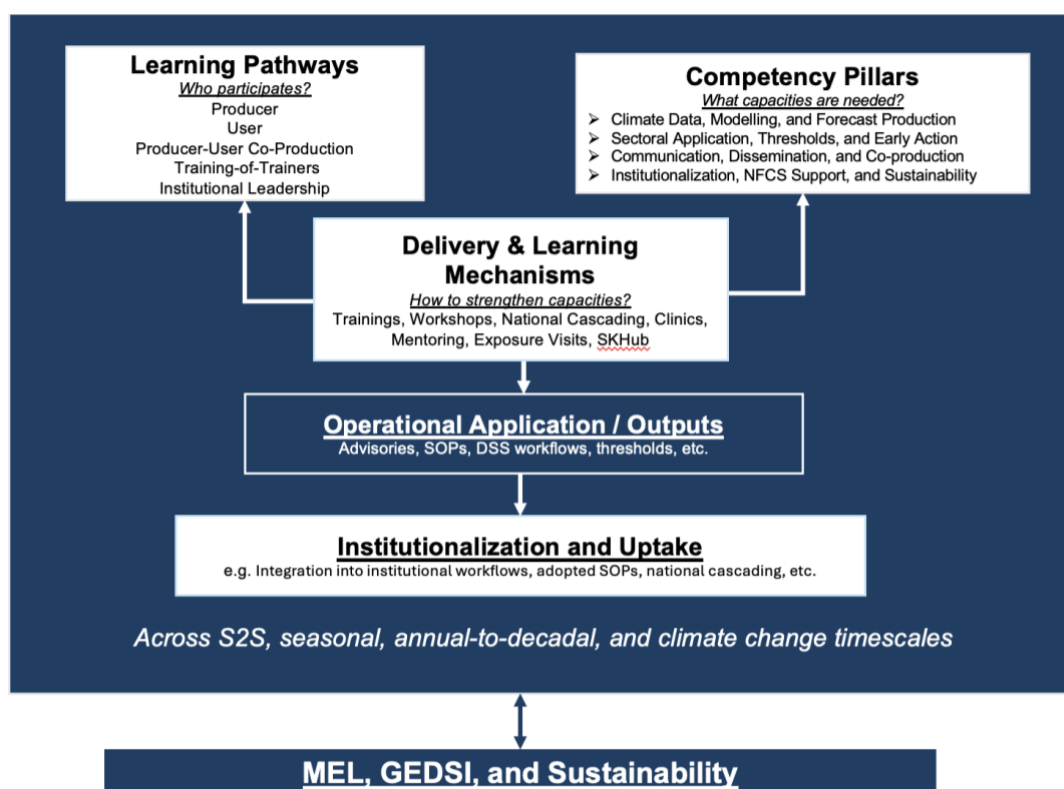


Figure 1. SAHF Regional Capacity Development Framework

1. Learning Pathways

The competency development pathways define the principal participant groups and institutional functions supported by the Framework. They recognize that climate service producers, user sector institutions, trainers, and institutional leaders require different competencies, levels of technical depth, and forms of learning.

The Framework includes pathways for:

- Climate service producers and technical personnel;
- user sector institutions;
- producer–user co-production groups;
- Training-of-Trainers participants; and
- institutional leadership and coordination personnel.

These pathways support role-based and progressive learning by helping institutions match participants with appropriate competency areas, delivery mechanisms, and expected applications. They are not mutually exclusive: participants may engage in

more than one pathway as their responsibilities and competencies develop. For example, an NMHS technical specialist may first participate in the producer pathway and later enter the Training-of-Trainers pathway, while an institutional focal point may participate in both producer–user and leadership activities.

2. Competency Pillars

The thematic competency pillars define the principal content areas through which technical, operational, user-oriented, and institutional capacities will be strengthened. While the competency pathways identify who the Framework supports, the pillars define what capacities should be developed.

The Framework is organized around four interrelated competency pillars:

- Climate Data, Modelling, and Forecast Production
- Sectoral Application, Thresholds, and Early Action
- Communication, Dissemination, and Co-production
- Institutionalization, NFCS Support, and Sustainability

Each participant pathway may draw from one or more pillars according to institutional role, existing competency level, and expected application. For example, NMHS forecasters may focus primarily on data, modelling, and forecast production, while user sector participants may engage more strongly with forecast interpretation, sectoral risk analysis, thresholds, and early action. Co-production groups, trainers, and institutional leaders may require competencies spanning several pillars.

The detailed competency areas and expected outputs under each pillar are presented in Section 5.

3. Delivery and Learning Mechanisms

The Framework will use a blended, modular, and progressive learning system that combines different delivery approaches according to the competency area, target participants, available resources, and operational context.

Delivery and learning mechanisms may include:

- regional technical training and hands-on laboratories
- producer–user learning workshops
- Training-of-Trainers and national cascading
- technical clinics, mentoring, and backstopping
- staff exchanges and embedded placements
- exposure visits and country-to-country learning
- communities of practice and peer learning
- virtual, hybrid, and self-paced learning through the SAHF Knowledge Hub

These mechanisms are intended to support both intensive technical learning and longer-term application. Introductory topics may be delivered through virtual sessions or preparatory Knowledge Hub modules, while advanced forecasting, modelling, data processing, and co-production activities may require in-person laboratories, modular programmes, mentoring, or practical assignments.

Capacity development activities should, where feasible, result in operational or institutional outputs such as datasets, scripts, forecast products, verification workflows, sectoral advisories, threshold matrices, SOPs, decision-support workflows, training materials, or institutional action plans.

Detailed delivery and learning mechanisms are presented in Section 6, while possible training delivery partners are discussed in Section 7.

4. Institutionalization and Regional Coordination

The Framework seeks to ensure that capacity development extends beyond individual participation and is embedded within institutional systems, operational workflows, and regional mechanisms. Implementation will therefore follow a phased pathway that moves from establishing and validating the Framework to developing core competencies, applying learning through operational products and processes, and institutionalizing capacities over time.

Institutionalization may include:

- integration of competencies into staff-development and training plans
- adoption or improvement of SOPs and operational workflows
- integration of tools and DSSs into service-delivery processes
- establishment of structured provider-user engagement and feedback mechanisms
- support to NFCS-related coordination arrangements
- development of national and institutional training pathways
- retention and transfer of learning through Training-of-Trainers and knowledge-management systems
- allocation of institutional responsibilities and resources for continued implementation

Regional coordination will be led through the SAHF Climate Services Working Group, in collaboration with NMHSs, Regional Climate Centres, WMO Regional Training Centres, regional technical partners, user sector institutions, and relevant SAHF Working Groups. This coordination will support common regional priorities while allowing activities and outputs to be adapted to national capacities, mandates, hazards, sectors, and operational requirements.

The phased implementation approach is presented in Section 8, while roles and coordination arrangements are described in Section 9.

5. MEL, GEDSI, and Sustainability

Monitoring, Evaluation, and Learning (MEL); Gender Equality, Disability, and Social Inclusion (GEDSI); and sustainability are cross-cutting elements of the Framework rather than separate end-stage activities.

MEL will assess not only the number of activities and participants, but also:

- changes in knowledge and competencies

- application of learning in operational practice
- development or improvement of products, tools, and workflows
- institutional adoption of SOPs and processes
- provider–user engagement and co-production
- national cascading and institutional knowledge transfer
- continued use and sustainability of capacities after training

MEL findings will be used to revise priorities, improve participant selection, refine modules and delivery approaches, and inform subsequent implementation cycles.

GEDSI considerations will be integrated into participant nomination, learning design, facilitation, accessibility, product development, communication, and monitoring. The Framework will promote inclusive participation and strengthen understanding of how climate risks, information access, communication channels, decision-making authority, and service usability differ among stakeholder groups.

Sustainability will be supported through Training-of-Trainers, national cascading, reusable learning materials, the SAHF Knowledge Hub, mentoring, communities of practice, institutional action plans, periodic regional training, partnerships, and resource mobilization. These measures are intended to reduce dependence on one-off projects and individual participants and to establish a continuing regional system for climate-services capacity development.

The detailed MEL and adaptation approach is presented in Section 10, while long-term sustainability arrangements are discussed in Section 11.

These elements provide a structured approach for moving from capacity needs identification and learning to operational application, institutional uptake, and sustained regional cooperation. The architecture recognizes that effective climate services depend not only on technical knowledge, but also on appropriate data and tools, institutional systems, operational procedures, provider–user relationships, inclusive participation, knowledge-transfer mechanisms, and continued technical and financial support.

4 COMPETENCY DEVELOPMENT (LEARNING) PATHWAYS

The Framework adopts a competency development approach to ensure that capacity building is progressive, role-based, and linked to institutional functions. Rather than treating all participants as a single training group, the Framework defines differentiated learning pathways for climate service producers, user sector institutions, trainers, managers, and regional resource persons.

These pathways are intended to help participating institutions identify the right participants, match them with relevant learning opportunities, and support the application of learning within institutional systems. They also provide a basis for developing national training plans, ToT pathways, staff development plans, and competency-based learning modules.

Table 2. Summary of Participant Pathways

Participant Pathway	Core Topics	Competency Levels
Producer pathway	Climate data quality management; gridded datasets; S2S and seasonal forecasting; NWP/climate model interpretation; verification; dissemination	Foundational, intermediate, advanced (depending on technical roles)
User sector pathway	Decision contexts; Access and use of climate information; Forecast interpretation; uncertainty; sectoral decision calendars; thresholds; translation of climate information into action	Primarily foundational and intermediate; advanced for specialized technical users
Producer–user co-production pathway	Threshold development; advisory co-production; CSUF translation; dissemination pathways; feedback mechanisms	Intermediate, with foundational orientation where needed
Training-of-Trainers pathway	Selected technical modules; facilitation skills; training design; module adaptation; cascade planning	Advanced subject-matter competency with facilitation competency
Institutional leadership pathway	NFCS support packages; SOPs; institutional workflows; resource mobilization; decision-maker engagement; MEL	Intermediate to advanced institutional and coordination competency

Competency Levels and Progression

The Framework will adopt progressive competency level to ensure that capacity development activities are matched to participants' existing knowledge, institutional responsibilities, and expected application of learning. The TNA showed substantial variation in technical and institutional capacity across countries, institutions, professional roles, and individual respondents. Capacity development should not assume that all participants require the same level of instruction or can proceed directly to advanced technical topics.

Three indicative competency levels will be applied across the learning pathways:

- 1) **Foundational Level** – develops the basic knowledge and practical understanding required to participated effectively in climate service processes.

- 2) **Intermediate Level** – develops the capacity to apply established methods independently and produce operationally relevant outputs. Learning at this level is expected to support routine operational application within the NMHSs and/or sector institutions.
- 3) **Advanced Level** – develops the ability to adapt methods, address complex technical or institutional problems, assure quality, mentor others, and lead operational improvement. Advanced competency does not automatically qualify a participant as a trainer. Participants entering the Training-of-Trainers pathway should also demonstrate facilitation ability, institutional support, and the capacity to adapt and deliver learning to others.

Table 3. Indicative Competency-Level Matrix

Competency level	Expected capability	Typical learning focus	Illustrative evidence of competency
Foundational	Understand concepts and undertake basic tasks with guidance	Terminology, principles, product orientation, basic interpretation, introduction to tools and procedures	Correctly interprets a standard product; completes a guided exercise; follows an established procedure
Intermediate	Independently apply established methods and produce operational outputs	Practical application, analysis, use of tools, product development, communication, and integration into decisions	Produces a forecast analysis, advisory, visualization, decision calendar, workflow, or sectoral interpretation
Advanced	Adapt methods, assure quality, solve complex problems, and guide others	Advanced analysis, method adaptation, quality assurance, institutionalization, mentoring, and technical leadership	Develops or improves a methodology, SOP, localized product, training resource, or institutional system; mentors or technically supports others

4.1 Producer competency pathway

This pathway is intended for NMHS technical staff, RCC staff, climate analysts, forecasters, modelers, data managers, GIS and IT personnel, and climate service officers involved in the production and delivery of climate information. The producer pathway supports the strengthening of NMHS capacities to produce reliable, timely, and user-oriented climate information across different timescales.

Core competencies under this pathway include:

- Climate data management, data handling, metadata, and quality control
- Development, validation, and application of gridded observation datasets
- Integration of satellite and ground observation datasets
- Access and use of regional datasets, tools, and platforms, including DataEx where relevant
- S2S and seasonal forecasting
- NWP model interpretation, climate modelling, downscaling, and bias correction
- Forecast verification, climate diagnostics, and attribution

- Product generation, advisory development, and climate information dissemination
- IT skills for meteorologists, including scripting, automation, database management, visualization, and digital platform operation
- User engagement, co-production, and communication of uncertainty

4.2 User sector competency pathway

This pathway is intended for representatives from climate-sensitive sectors such as agriculture, disaster risk reduction, water resources, health, energy, infrastructure, transport, humanitarian action, planning, environment, and local government.

The pathway aims to strengthen the capacity of user-sector institutions to access, understand, interpret, communicate, and apply climate information in operational and strategic decision-making. It recognizes that access to climate information does not automatically lead to effective use. Users also require the knowledge, institutional guidance, tools, and engagement mechanisms needed to connect climate information with specific decisions, timelines, risks, thresholds, and actions.

Core competencies under this pathway include:

- Understanding the context in which climate information is utilized in sectoral decisions considering different decision contexts, planning cycles and availability of resources
- Understanding climate products, forecast types, timescales, probabilities, and uncertainty
- Interpreting seasonal, S2S, and other climate information in relation to sectoral decisions
- Translating forecasts and advisories into planning, preparedness, and operational actions
- Identifying sectoral decision calendars, thresholds, triggers, and response options
- Applying climate information in contingency planning, early action, risk assessment, and policy processes
- Providing structured feedback to NMHSs and climate service producers
- Participating in CSUF, National Outlook Forums, and other producer–user mechanisms

4.3 Producer–user co-production pathway

This pathway brings together NMHSs, regional partners, intermediaries, and user sector institutions for joint learning and applied exercises. It is particularly relevant for CSUF operationalization, threshold development, advisory design, dissemination planning, and early action guidance. It supports the Framework’s goal of integrating producer and user capacity development across the climate services value chain.

Core competencies under this pathway include:

- Joint interpretation of climate outlooks and uncertainty
- Co-development of sectoral advisories and user-oriented products
- Threshold and trigger-action matrix development

- Translation of climate hazards into sectoral implications
- Feedback collection and use
- Design of dissemination pathways and communication products
- Documentation of lessons from seasonal cycles

4.4 Training-of-Trainers pathway

This pathway is intended for selected participants who will support national and sub-national training replication. This pathway is central to institutionalizing capacity development beyond individual workshops and beyond the project timeline. ToT participants should not be treated as a completely separate participant group, rather a cross-cutting pathway for selected producer and user sector participants who have the potential to become trainers or resource persons.

Selected participants will first strengthen competencies relevant to their institutional role, and will then receive additional training in facilitation, module adaptation, mentoring, and cascade delivery. This approach ensures that national and sub-national trainings are delivered by individuals who have both subject-matter grounding and the ability to contextualize content for their institutions and sectors.

Core competencies under this pathway include:

- Technical mastery of selected climate services topics
- Facilitation and adult learning methods
- Training design, adaptation, and delivery
- Development of national or sector-specific training modules
- Co-facilitation of regional and national trainings
- Mentoring of new participants
- Documentation and reporting of cascade trainings

4.5 Institutional leadership and coordination pathway

This pathway is intended for NMHS managers, unit leads, planning officers, NFCS focal points, CSUF/NCOF coordinators, and representatives responsible for institutional processes and inter-agency coordination. This pathway ensures that technical learning is translated into institutional systems and sustained operational practice.

Core competencies under this pathway include:

- Integration of climate services into institutional mandates, SOPs, and workflows
- Development and use of NFCS support packages
- Coordination of producer–user mechanisms
- Resource planning and sustainability
- Monitoring, evaluation, and documentation of climate service outcomes
- Coordination with SAHF working groups, RCCs, and regional partners
- Institutionalization of training outputs and competency frameworks

Participant Pathways and Nomination Guidance

The Framework will use differentiated participant pathways to ensure that the right participants are matched with the right learning opportunities. The following participant pathways are recommended:

Pathway	Target Participants	Main Focus
Producer pathway	NMHS technical staff, forecasters, data managers, modelers, GIS/IT personnel	Climate data, forecasting, modelling, products, dissemination
User sector pathway	Agriculture, DRR, water, health, energy, planning, humanitarian, and other sectoral agencies	Forecast interpretation, translation, thresholds, decisions
Producer-user co-production pathway	NMHSs, user sectors, intermediaries	Advisories, thresholds, CSUF, feedback, dissemination
ToT pathway	Selected NMHS, user sector, training centre, or partner representatives	Training delivery, module adaptation, national cascading
Institutional leadership pathway	NMHS managers, unit heads, NFCS focal points, CSUF/NCOF coordinators	Institutionalization, SOPs, coordination, sustainability

Nomination should consider:

- Relevance of the participant's role to the training topic;
- Ability to apply learning in operational or planning contexts;
- Institutional support for participation and follow-up application;
- Continuity of participation across phases where feasible;
- Gender balance and inclusion of underrepresented groups;
- Inclusion of early-career professionals and technical staff with long-term institutional roles;
- Selection of ToT candidates with both technical competence and facilitation potential.

5 COMPETENCY PILLARS

The competency development pathways identify the different groups of participants and institutions that the Framework is intended to support, while the thematic competency pillars define the main subject areas through which these capacities will be developed. The pathways and pillars are therefore complementary: the pathways clarify who requires capacity development and for what institutional function, while the pillars define the priority content areas that can be combined and sequenced according to each group's role, mandate, and level of technical need.

In practice, each participant pathway may draw from one or more thematic pillars. For example, NMHS technical staff may require deeper engagement with climate data, modelling, forecasting, and product generation, while user sector participants may focus more on forecast interpretation, thresholds, sectoral application, and decision-making. Training-of-Trainers candidates and institutional focal points may engage across multiple pillars to support national cascading, institutionalization, and sustainability.

The Framework is organized around four priority competency pillars that define the main content areas for climate services capacity development. These pillars ensure that the Framework covers the full climate services value chain, from data and forecast production to user application, communication, institutionalization, and sustainability.

The four pillars are:

1. Climate Data, Modelling, and Forecast Production
2. Sectoral Application, Thresholds, and Early Action
3. Communication, Dissemination, and Co-production
4. Institutionalization, NFCS Support, and Sustainability

The Framework is organized around four priority competency pillars that reflect the core capacities required to strengthen climate services across South Asia. These pillars build on the findings from the TNA and discussions within the Climate Services Working Group covering climate data and forecast foundations, sectoral impact assessment, communication and co-production, and institutionalization and sustainability. These are framed as long-term competency areas that support both individual learning and institutional capacity development.

The four pillars are interconnected. Climate data, modelling, and forecast production provide the technical basis for climate services. Sectoral application, thresholds, and early action translate climate information into decision-relevant guidance. Communication, dissemination, and co-production strengthen the producer–user interface. Institutionalization, NFCS support, and sustainability ensure that capacities are embedded within systems, workflows, and regional mechanisms.

Table 4. Summary Matrix of Competency Pillars

Competency pillar	Purpose and focus
Climate Data, Modelling, and Forecast Production	Strengthen the technical capacity of NMHSs and regional institutions to access, manage, analyse, generate, verify, localize, and communicate reliable climate information across timescales.
Sectoral Application, Thresholds, and Early Action	Strengthen the capacity of climate-service producers and user sectors to translate climate information into sector-specific risk analysis, advisories, preparedness measures, operational decisions, and early action.
Communication, Dissemination, and Co-production	Strengthen the provider–user interface so that climate information is understandable, accessible, relevant, inclusive, and responsive to sectoral needs and feedback.
Institutionalization, NFCS Support, and Sustainability	Embed climate-service capacities within institutional mandates, governance arrangements, operational procedures, financing systems, knowledge-transfer mechanisms, and regional coordination structures.

5.1 Climate Data, Modelling, and Forecast Production

This pillar focuses on strengthening the technical capacities of NMHSs to access, manage, analyze, produce, and communicate climate information. It responds to the need for improved technical capacity in areas such as data quality management, gridded observation datasets, S2S and seasonal forecasting, NWP model interpretation, climate modelling, downscaling, bias correction, attribution, and IT skills for meteorologists.

This pillar will support competencies in:

- Climate data management, data handling, metadata, and documentation
- Climate data quality management and modern quality control techniques
- Development, validation, and operational use of regional gridded observation datasets
- Integration of satellite and ground observation datasets for climate trend analysis, monitoring, and verification
- Access and use of regional datasets, tools, and data-sharing platforms, including DataEx where relevant
- S2S and seasonal forecasting, including interpretation of multi-model ensemble products
- NWP model interpretation, climate model outputs, downscaling, and bias correction
- Forecast verification, skill assessment, climate diagnostics, and attribution
- IT skills for meteorologists, including scripting, workflow automation, database management, GIS/geospatial analysis, visualization, and digital platform use

Training under this pillar should be highly practical and data-driven. It may include technical laboratories, hands-on exercises, case studies, regional data clinics, model interpretation sessions, and secondments with RCCs, NMHSs, or technical partner institutions. The goal is

not only to improve technical knowledge, but to strengthen operational workflows that enable NMHSs to generate reliable, timely, localized, and user-relevant climate information.

5.2 Sectoral Application, Thresholds, and Early Action

This pillar focuses on translating climate information into sectoral implications, thresholds, advisories, and guidance for preparedness and early action. It responds to the continuing gap between the availability of climate information and its systematic use in decision-making.

This pillar will support competencies in:

- Sectoral impact assessment and risk pathway analysis
- Identification of exposure, vulnerability, and sectoral decision contexts
- Development, testing, and validation of sector-specific thresholds
- Use of historical climate and impact data to inform threshold development
- Development of trigger-action matrices and decision points
- Linking S2S and seasonal forecasts to sectoral decision calendars
- Translation of climate hazards into potential impacts for agriculture, DRR, water, health, energy, infrastructure, and other sectors
- Development of sector-specific advisories and early action guidance
- Integration of climate information into anticipatory action, contingency planning, and preparedness systems
- Coordination with IBF, DSS, early warning, and other SAHF workstreams

This pillar should be closely coordinated with other relevant SAHF working groups. The Climate Services Framework should focus on climate information and services across S2S, seasonal, decadal, and climate change timescales, while ensuring complementarity with weather-scale IBF, early warning, anticipatory action, and sectoral decision-support processes.

5.3 Communication, Dissemination, and Co-production

This pillar focuses on strengthening the producer–user interface. It addresses the need to improve how climate information is communicated, disseminated, interpreted, translated, and refined through feedback. Communication has been identified as a major challenge, particularly around simplifying technical information, communicating uncertainty, and tailoring messages for different sectors.

This pillar will support competencies in:

- Communication of probabilistic forecasts, uncertainty, and confidence
- Development of clear, actionable, and user-oriented climate advisories
- Climate information dissemination strategies and channel mapping
- Product packaging for different user groups and decision contexts
- Forecast interpretation and translation for user sectors
- Co-production approaches and participatory product design
- Stakeholder mapping and user needs assessment

- Feedback collection, documentation, and integration into service improvement
- Inclusive and GESI-sensitive climate communication
- CSUF operationalization package and producer–user translation cycles

Under this pillar, CSUF should be treated as an applied learning mechanism, not only as a forum. Through CSUF-linked activities, producers and users can jointly interpret outlooks, identify sectoral implications, develop advisories, discuss thresholds, review user needs, and document feedback for future improvement. This links regional outlook production to sectoral uptake and national dissemination.

5.4 Institutionalization, NFCS Support, and Sustainability

This pillar focuses on embedding climate services capacity within institutional systems, national frameworks, and regional mechanisms. It recognizes that training only becomes sustainable when it is translated into competencies, workflows, SOPs, products, coordination mechanisms, and institutional mandates.

This pillar will support competencies in:

- Development and use of NFCS support packages
- Institutional coordination for climate services
- Development of SOPs for climate service production, dissemination, feedback, and review
- Integration of climate information into DSS and institutional workflows
- Competency frameworks for NMHSs and user sector institutions
- Training-of-Trainers and national cascading
- Monitoring, evaluation, and documentation of climate service outcomes
- Resource mobilization and sustainability planning
- SKHub-based learning pathways and knowledge management
- Exposure visits, country-to-country learning, mentoring, and regional communities of practice
- Coordination with RCCs, WMO Regional Training Centres, SASCOF, CSUF, and SAHF working groups

This pillar ensures that capacity development extends beyond individual trainings and project timelines. It supports the institutionalization of products, capacities, and mechanisms that can continue to evolve through RCC-led support, national training systems, regional cooperation, and the SAHF Knowledge Hub.

6 DELIVERY AND LEARNING MECHANISMS

The Framework will use a blended, modular, and progressive set of delivery and learning mechanisms through in-person, hybrid, virtual, and asynchronous modalities, supported by hands-on learning, peer exchange, mentoring, technical backstopping, ToT, secondments, and utilization of SKHub. Under the Framework, these are treated as complementary mechanisms that can be combined depending on the competency area, participant group, and institutional objective.

Table 5. Summary Matrix of Delivery and Learning Mechanisms

Delivery and learning mechanism	Purpose and appropriate use	Typical delivery format
Regional Technical Training	Build foundational, intermediate, and advanced technical competencies that require structured instruction, hands-on practice, and access to specialized expertise, datasets, models, and tools. Particularly appropriate for technical topics that cannot be adequately covered through short briefings or self-paced learning alone.	In-person or hybrid technical courses; hands-on forecasting or data laboratories; regional data clinics; multi-session or modular programmes; pre-SASCOF technical training; short-term secondments or embedded placements.
Provider–User Learning Workshops	Strengthen the interpretation and application of climate information by bringing producers and users together around actual decisions, outlooks, risks, thresholds, and sectoral needs. These workshops support practical co-production rather than one-way dissemination.	In-person or hybrid workshops; facilitated group exercises; sector case studies; simulations; forecast-interpretation sessions; SASCOF-, CSUF-, or NCOF-linked sessions; pre-season, mid-season, and post-season learning activities.
Training-of-Trainers and National Cascading	Develop a pool of regional and national trainers capable of adapting, delivering, and sustaining climate-services capacity development within their institutions and countries. This mechanism supports wider reach, institutional knowledge transfer, and reduced dependence on external trainers.	Dedicated ToT workshops; participation in technical training; facilitation and instructional-design sessions; observation and assisted facilitation; co-facilitation of regional or national activities; national and sub-national cascade training; mentoring and trainer communities of practice.
Technical Clinics, Mentoring, and Backstopping	Help participants apply training in operational settings, troubleshoot technical problems, refine products and workflows, and maintain learning after formal courses. Best suited to focused, problem-driven support rather than broad instruction.	Short virtual or in-person clinics; one-to-one or team mentoring; scheduled office hours; peer review; product-development sessions; remote troubleshooting; periodic follow-up meetings; embedded technical assistance.

Exposure Visits and Country-to-Country Learning	Facilitate practical peer learning by allowing institutions to observe established systems, operational practices, and institutional arrangements in countries or organizations with relevant experience.	Structured exposure visits; staff exchanges; peer missions; short-term placements; country-to-country technical exchanges; study visits to Regional Climate Centres, NMHSs, training institutions, or user sector organizations.
SAHF Knowledge Hub-Based Learning	Provide continued access to learning resources, support pre-training preparation and post-training reinforcement, preserve institutional knowledge, and extend access to personnel unable to attend synchronous activities. It should complement, not replace, interactive and hands-on learning.	Self-paced modules; recorded sessions; instructional videos; downloadable materials; datasets and practical exercises; facilitator guides; discussion spaces; assessments; resource repositories; curated learning pathways by role and competency level.
Communities of Practice and Peer Learning	Sustain regular exchange among practitioners working on similar technical, operational, or user-engagement challenges and support continued learning between formal activities.	Periodic virtual discussions; thematic working groups; peer-review sessions; online discussion channels; regional knowledge exchanges; case presentations; collaborative problem-solving sessions.

6.1 Regional Technical Trainings

Regional technical trainings will be a core mechanism for strengthening specialized producer capacities. These trainings should go beyond one-off pre-COF sessions and support periodic capacity building through RCCs, WMO Regional Training Centres, NMHSs, and other regional technical partners.

These trainings may cover:

- S2S and seasonal forecasting
- NWP model interpretation
- Climate modelling, downscaling, and bias correction
- Forecast verification and skill assessment
- Regional gridded datasets
- Climate data quality management and modern quality control
- Integration of satellite and ground observations
- Data sharing and DataEx-related workflows
- IT skills for meteorologists

These may be delivered as week-long technical trainings, annual or semi-annual refresher courses, technical laboratories, regional data clinics, or short-term secondments. Outputs should include not only trained participants, but also practical products such as workflows, datasets, scripts, QC procedures, guidance notes, and operational templates.

6.2 Producer-User Learning Workshops

Producer-user learning workshops will bring together NMHSs, RCCs, regional partners, and user sector institutions to jointly interpret climate information and translate it into sectoral applications.

These workshops may focus on:

- Forecast interpretation and translation
- Understanding probabilities, uncertainty, and confidence
- Sectoral decision calendars
- Threshold development and validation
- Advisory co-production
- Trigger-action matrices
- Early action guidance
- Dissemination pathways
- Feedback mechanisms

CSUF operationalization should be embedded under this mechanism. The Framework can support a CSUF-linked learning cycle that includes pre-SASCOF user needs identification, consensus outlook interpretation during SASCOF, producer–user translation during CSUF, National Climate Outlook Forums (NCOFs) after SASCOF/CSUF, mid-season virtual reviews, and post-season learning reviews.

6.3 Training-of-Trainers and National Cascading

The Framework will include a structured ToT pathway to develop a pool of national and regional trainers who can support training replication and institutionalization. ToT is an important mechanism for scaling and sustainability, including facilitation skills, training design, contextualization, co-facilitation, mentoring, and national cascading.

ToT topics should include:

- Technical grounding in selected competency pillars
- Facilitation and adult learning methods
- Training design and module adaptation
- Co-facilitation of regional and national trainings
- Development of national or sectoral training packages
- Mentoring and peer support
- Documentation of cascade training results

ToT candidates may come from NMHSs, RCCs, user sector institutions, training centres, or partner organizations. Where appropriate, user sector representatives may also be included in the ToT pathway to support institutional uptake and sectoral translation of climate information.

6.4 Technical Clinics, Mentoring, and Backstopping

Technical clinics, mentoring, and backstopping will help ensure that training outputs are applied in practice. These mechanisms are especially important for supporting participants after formal training sessions, troubleshooting operational challenges, and refining products or workflows.

They may support:

- Data quality control workflows
- Gridded dataset development
- Forecast verification
- Model interpretation
- Threshold refinement
- Advisory development
- SOP drafting
- DSS integration
- NFCS support package development
- CSUF and National Outlook Forum preparation

Technical clinics may be delivered virtually or in-person. They should be short, focused, and problem-driven. Mentoring may be provided by RCCs, regional technical partners, or experienced NMHSs through structured follow-up arrangements.

6.5 Exposure Visits and Country-to-Country Learning

Exposure visits and country-to-country learning will strengthen peer learning across South Asia. They will allow NMHSs and user sector institutions to learn directly from countries or institutions with more advanced or operationalized practices.

Exposure visits may focus on:

- RCC operations
- Seasonal forecasting workflows
- Climate data management systems
- Gridded dataset production
- Data-sharing platforms
- DSS operations
- CSUF or National Outlook Forum processes
- Threshold development
- Advisory dissemination
- NFCS implementation
- Producer-user engagement mechanisms

Each exposure visit should have clear learning objectives, host institutions, expected outputs, and post-visit knowledge-sharing requirements. Outputs may include a learning note, institutional action plan, presentation to the CS WG, or contribution to SKHub resources.

6.6 SKHub-Based Learning Management System

The SAHF Knowledge Hub will serve as a long-term learning and knowledge management platform for the Framework. It should support pre-learning, post-training reinforcement, ToT, national cascading, and institutional memory.

SKHub may host:

- Self-paced learning modules
- Recorded sessions
- Training materials and facilitator guides
- Datasets and practical exercises
- QC workflow templates
- Forecast verification tools
- Advisory templates
- Threshold development guidance
- SOP examples
- NFCS support package templates
- CSUF and National Outlook Forum resources
- Case studies and learning reviews

SKHub should not replace in-person or interactive training. Instead, it should complement them by enabling continuity, access to resources, refresher learning, and wider dissemination across countries and institutions.

Addressing Barriers to Participation

The Framework recognizes that effective capacity development depends not only on the relevance of training content, but also on the ability of participants and institutions to engage consistently. Barriers identified through the TNA include budget limitations, management approval requirements, staff turnover, connectivity constraints, unclear agendas or training benefits, and time constraints. These barriers will be addressed through flexible delivery design, early institutional coordination, clear communication of training value, and mechanisms for knowledge retention.

To reduce financial barriers, the Framework will use a blended delivery model that combines in-person, hybrid, virtual, and asynchronous learning. Where feasible, training activities will be co-located with existing regional events such as SASCOF, CSUF, or SAHF working group meetings to reduce travel costs and maximize participation. SKHub-based learning modules, recordings, and downloadable materials will also be used to extend access beyond those able to attend in person.

To support management approval, SAHF and training partners will provide clear training briefs well in advance of each activity. These should specify the objectives, target participants, expected outputs, institutional relevance, time commitment, and anticipated benefits. This will help NMHSs and user sector institutions justify participation and nominate staff whose roles are directly aligned with the training objectives.

To address staff turnover, the Framework will emphasize institutionalization rather than individual training alone. Training materials, datasets, exercises, facilitator guides, SOP templates, advisory templates, and recordings will be maintained through SKHub. The ToT pathway and national cascading approach will also help build a wider pool of trained personnel and reduce dependence on a small number of individuals.

To address connectivity constraints, virtual and hybrid sessions will be designed with low-bandwidth participation options. Materials should be shared in advance, sessions should be recorded where appropriate, and asynchronous learning options should be made available through SKHub. Live virtual sessions should be kept focused and interactive, but not overly long.

To address unclear agendas or perceived training benefits, each training activity should be linked to specific competency pathways, expected outputs, and institutional applications. Participants should understand how the training relates to their role, whether in data management, forecasting, forecast interpretation, advisory development, CSUF/NCOF participation, SOP development, DSS integration, or national cascading.

To address time constraints, the Framework will use modular training design. Longer technical training sessions may be reserved for hands-on topics that require intensive practice, while shorter virtual sessions, technical clinics, and refresher modules may be used for follow-up, troubleshooting, and reinforcement. Training schedules should consider operational calendars, seasonal outlook cycles, and institutional workload periods.

Table 6. Summary of Barriers to Participation and Proposed Mitigation to Address Barriers

Barrier category	Indicative mitigation
Resource and participation constraints	Plan activities early; use modular, hybrid, and event-linked delivery; clarify costs and institutional commitments.
Workload, staffing, and turnover	Apply role-based nominations; train more than one person for critical functions; provide protected time, cascade training, and documented handover.
Differences in competency and relevance	Assess participant level and prerequisites; tailor content by role; link training to a defined operational or institutional output.
Limited data, tools, infrastructure, or institutional support	Assess enabling requirements before delivery and link training with technical assistance, management action, infrastructure, or financing where needed.
Limited follow-up and sustainability	Use mentoring, technical clinics, peer learning, ToT, SKHub resources, and MEL to support continued application.
Accessibility and inclusion barriers	Use accessible formats, low-bandwidth options, inclusive nominations, and GESI-responsive facilitation and materials.

7 TRAINING DELIVERY PARTNERS

The delivery of the capacity building activities will draw on a diverse pool of regional and international technical partners, selected based on their demonstrated expertise and ongoing engagement in climate services and sectoral applications in South Asia.

At this stage, the organizations identified below are indicative and not prescriptive. The final composition of training providers will be determined through targeted consultations and coordination led by the SAHF Team, in alignment with specific training themes, country needs, and availability of technical resources. This process will ensure that training delivery is context-specific, demand-driven, and effectively resourced.

In preparation for implementation, the SAHF Team will:

- ✧ Conduct consultations with identified organizations to align training content, roles, and delivery modalities
- ✧ Map each organization's expertise to the four training themes and specific modules
- ✧ Establish clear roles and coordination mechanisms among partners to avoid duplication and ensure complementarity
- ✧ Develop a roster of trainers and resource persons, including regional and national experts
- ✧ Ensure alignment with ongoing regional initiatives and platforms (e.g., SASCOF & CSUF)

The organizations listed below represent key institutions whose technical expertise are highly relevant to the training priorities identified through the TNA. These information is summarized on Table 4.

RIMES South Asia Hydromet Forum (RIMES / SAHF)

RIMES, through its role as the secretariat for SAHF, serves as the primary regional coordination and implementation platform of climate services and IBF capacity development in South Asia. It plays a central role in bridging regional initiatives, NMHS operations, and user sector applications.

Strengths and Expertise:

- End-to-end climate services delivery
- Operational implementation of IBF frameworks across sectors
- Development and deployment of decision support systems (DSSs)
- Strong regional coordination and stakeholder mechanisms
- Experience in training design, facilitation, and follow-through support

Areas for Collaboration / Relevant Initiatives:

- ✧ Lead coordination and implementation of training activities
- ✧ Facilitation of regional platforms and working groups
- ✧ Post-training technical backstopping and mentoring
- ✧ Knowledge management through the SAHF Knowledge Hub

World Meteorological Organization (WMO)

WMO provides global leadership in weather, climate, and water, including the development of frameworks, standards, and capacity development initiatives for climate services.

Strengths and Expertise:

- Guidance on Global and Regional Framework for Climate Services (GFCS and RFCS)
- Standardization of climate services practices and methodologies
- Capacity development frameworks and training resources
- Coordination of RCCs, NMHSs, and global initiatives

Areas for Collaboration / Relevant Initiatives:

- ✘ Alignment of training content with GFCS pillars and competency frameworks
- ✘ Guidance on NFCS development and institutionalization
- ✘ Provision of global tools, standards, and training materials

WMO Regional Training Centres (RTCs)

WMO RTCs are a global network of WMO-designated institutions that provide standardized education and professional training for NMHS personnel in meteorology, hydrology, and climate services.

Strengths and Expertise:

- ✘ Delivery of accredited and competency-based training programmes
- ✘ Established curricula aligned with WMO standards and frameworks
- ✘ Regional training infrastructure and experienced faculty
- ✘ Long-standing role in NMHS capacity development

Areas for Collaboration / Relevant Initiatives:

- ✘ Delivery of structured technical training modules (e.g., forecasting, data analysis, climate services)
- ✘ Support for certification and formal training pathways
- ✘ Potential hosting of regional or sub-regional training sessions
- ✘ Alignment with WMO competency frameworks and professional standards

UK Met Office (UKMO)

UKMO is a global leader in weather and climate science and a key implementing partner of the WISER Programme in South Asia.

Strengths and Expertise:

- IBF frameworks and operationalization
- Ensemble forecasting, probabilistic products, and risk communication
- Climate services co-production and user engagement
- Capacity development and training design

Areas for Collaboration / Relevant Initiatives:

- Delivery of IBF and decision-support training modules
- Training on uncertainty communication and forecast interpretation

- Support to user engagement processes and CSUF-related activities

UN Economic and Social Commission for Asia and the Pacific (ESCAP)

ESCAP supports regional cooperation and capacity building in disaster risk reduction, climate resilience, and sustainable development across Asia and the Pacific.

Strengths and Expertise:

- Regional policy coordination and development planning
- Risk and resilience analytics
- Multi-sectoral engagement and data platforms

Areas for Collaboration / Relevant Initiatives:

- ✧ Integration of climate services into policy and planning
- ✧ Training on risk-informed decision-making
- ✧ Support to cross-sectoral and transboundary applications

European Centre for Medium-Range Weather Forecasts (ECMWF)

ECMWF is an independent, intergovernmental organization and a global leader in numerical weather prediction (NWP) and climate forecasting.

Strengths and Expertise:

- ✧ Advanced ensemble prediction systems
- ✧ Probabilistic forecasting and uncertainty quantification
- ✧ Extreme Forecast Index (EFI) and anomaly detection
- ✧ Copernicus Climate Data Store and reanalysis datasets

Areas for Collaboration / Relevant Initiatives:

- ✧ Training on ensemble forecast interpretation and verification
- ✧ Application of probabilistic products for IBF
- ✧ Use of Copernicus datasets for climate analysis

Regional Climate Centre Pune (RCC Pune)

RCC Pune, hosted by the India Meteorological Department (IMD), is the designated WMO Regional Climate Centre for South Asia, providing mandated regional climate services including long-range forecasting, climate monitoring, and guidance to NMHSs.

Strengths and Expertise:

- ✧ Seasonal forecasting and consensus outlook development
- ✧ Climate monitoring and diagnostics
- ✧ Regional product generation and verification

Areas for Collaboration / Relevant Initiatives:

- ✧ Pre-SASCOF training and seasonal forecasting capacity development
- ✧ Guidance on forecast generation and interpretation
- ✧ Integration of regional products into national workflows

National Centre for Medium-Range Weather Forecasting (NCMRWF)

NCMRWF is an operational and research institution under the Ministry of Earth Sciences, Government of India, specializing in NWP and medium-range forecasting.

Strengths and Expertise:

- Operational NWP systems and ensemble prediction
- Medium-range to extended-range (S2S) forecasting
- Data assimilation and model development

Areas for Collaboration / Relevant Initiatives:

- Training on interpretation of model outputs
- Strengthening S2S forecasting workflows
- Forecast verification and performance assessment

Indian Institute of Tropical Meteorology (IITM)

IITM is a premier research institution under the Ministry of Earth Sciences in India, specializing in climate science, monsoon dynamics, and numerical modelling.

Strengths and Expertise:

- Climate modelling and monsoon dynamics
- S2S prediction research
- Climate variability and diagnostics

Areas for Collaboration / Relevant Initiatives:

- Training on climate modelling and projections
- Technical sessions on uncertainty and model interpretation
- Support for downscaling methodologies

International Water Management Institute (IWMI)

IWMI is a CGIAR research center focused on water resources management, with strong expertise in climate-water linkages and decision support for water-related sectors.

Strengths and Expertise:

- Hydro-climatic analysis and water risk assessment
- Basin-scale modelling and decision support tools
- Climate services for agriculture and water sectors

Areas for Collaboration / Relevant Initiatives:

- Sectoral training on water resource management
- Integration of climate information into planning
- Application of hydro-climatic tools and platforms

International Centre for Integrated Mountain Development (ICIMOD)

ICIMOD is a regional intergovernmental knowledge and development organization serving the Hindu Kush Himalaya (HKH) region, focusing on sustainable mountain development, climate change adaptation, water resources management, and disaster risk reduction.

Strengths and Expertise:

- ✧ Regional data systems and geospatial platforms
- ✧ Mountain hydrology and cryosphere analysis
- ✧ Transboundary risk and climate applications

Areas for Collaboration / Relevant Initiatives:

- Training on geospatial analysis and data integration
- Application of climate services in mountain contexts
- Cross-border collaboration and data sharing

Red Cross Red Crescent Climate Centre (RCCC)

RCCC integrates climate information into humanitarian action. It is a leading institution in operationalizing forecast-based action (FbA) and bridging the gap between climate science and early action on the ground.

Strengths and Expertise:

- Forecast-based action (FbA) and Early Action Protocols (EAPs)
- Translation of forecasts into humanitarian action
- Participatory approaches and risk communication

Areas for Collaboration / Relevant Initiatives:

- ✧ Training on IBF-to-action frameworks and triggers
- ✧ Simulation-based learning and co-production exercises
- ✧ Strengthening linkages between climate services and disaster response

World Food Programme (WFP)

WFP integrates climate and weather information into food security, disaster preparedness, and anticipatory action programmes, particularly in vulnerable contexts.

Strengths and Expertise:

- Anticipatory action and food security systems
- Operational use of forecasts in humanitarian contexts
- Early warning–early action frameworks

Areas for Collaboration / Relevant Initiatives:

- Linking climate information to early action triggers
- Integration into food security planning
- Case-based learning on operational applications

Table 7. Summary Matrix of Indicative Training Delivery Partners

Training delivery partner	Technical Expertise	Possible contribution to the Framework implementation
RIMES / SAHF	Regional coordination End-to-end climate services Impact-based forecasting DSS development User engagement Training and technical support	Coordinate implementation Convene partners Support DSS and climate-service applications Facilitate provider–user activities Manage regional learning resources
WMO	GFCS, RFCS, and NFCS guidance International standards; competency frameworks Institutional governance Climate-service systems	Provide standards Institutional guidance Competency frameworks NFCS support, and quality assurance
WMO Regional Training Centres	Competency-based professional education Established curricula Experienced faculty Training infrastructure WMO-aligned programmes	Deliver structured technical courses Develop progressive learning pathways Support regional trainers and formal professional development
UK Met Office	Ensemble and probabilistic forecasting Impact-based forecasting Uncertainty and risk communication Co-production; user engagement	Support training on forecast interpretation, impact-based approaches, uncertainty communication, co-production, and user-oriented service design
UN ESCAP	Regional policy coordination Disaster risk reduction Risk and resilience analytics Sustainable-development planning Regional data platforms	Support risk-informed planning, policy integration, multi-sector applications, and use of regional risk and resilience tools.
ECMRWF	NWP Ensemble prediction Probabilistic forecasting Forecast verification Uncertainty quantification Copernicus and reanalysis datasets	Provide advanced technical training on ensemble products, forecast verification, and uncertainty Use of ECMWF and Copernicus datasets
RCC-Pune / IMD	Regional climate monitoring Seasonal forecasting Consensus outlooks Verification Regional product development Support to SASCOF	Strengthen seasonal and S2S forecasting Interpretation and customization of regional outlooks Verification NMHS technical exchange
NCMRWF	Operational NWP Ensemble prediction Data assimilation Medium- and extended-range forecasting Model evaluation	Strengthen NWP and S2S workflows, model-output interpretation, data assimilation, and forecast-performance assessment.
IITM	Climate modelling Monsoon dynamics S2S prediction Climate variability and diagnostics Projections and downscaling	Support advanced training on monsoon and climate modelling, climate drivers, projections, diagnostics, downscaling, and research-to-operations applications.

IWMI	Hydroclimatic analysis Basin-scale modelling Water-risk assessment Agriculture and water decision-support systems	Support sectoral application of climate information in water management, agriculture, irrigation, drought management, and basin planning.
ICIMOD	Mountain hydrology Cryosphere monitoring Geospatial analysis Regional data systems Transboundary climate risks	Support geospatial, mountain, cryosphere, hydrological, and cross-border applications of climate information.
Red Cross Red Crescent Climate Centre	Forecast-based action Early Action Protocols Trigger development Humanitarian climate services Participatory methods Risk communication	Support development of thresholds, triggers, Early Action Protocols, anticipatory-action applications, and participatory provider–user processes.
WFP	Anticipatory action Food-security analysis Humanitarian early warning Operational forecast use Early warning–early action systems	Support food-security and humanitarian applications, including the translation of forecasts into triggers, advisories, preparedness, and early action.

8 IMPLEMENTATION PLAN

The Regional Training Framework will be implemented through a phased and progressive capacity development pathway over an indicative 24–36 month period. The implementation approach is designed to move from framework establishment, to core competency development, to operational application, and finally to institutionalization and sustainability.

These implementation phases are linked to the competency development pathways:

- Phase 1 establishes the overall framework and maps the relevant participant pathways.
- Phase 2 focuses on building core competencies among producers and user sector institutions.
- Phase 3 brings producers and users together to operationalize products, thresholds, advisories, CSUF-linked translation processes, SOPs, and workflows.
- Phase 4 focuses on institutionalization and sustainability, with particular emphasis on Training-of-Trainers, national cascading, institutional leadership, coordination mechanisms, and long-term capacity development.

Table 8. Overview of the Phased Implementation of the Capacity Development Framework

Phase	Main Function	Primary Pathways Emphasized	Core Outputs
Phase 1: Establish the Framework (Months 1-3)	Preparatory and design activities	All pathways identified and mapped	Validated framework, competency matrix, training calendar, partner roster, ToT pool, SKHub structure
Phase 2: Deliver Core Competency Training (Months 4-12)	Build foundational and technical capacities for producers and users	Producer pathway; user sector pathway; initial ToT pathway	Trained producer and user cohorts, technical workflows, datasets, scripts, interpretation guides, draft advisory templates
Phase 3: Operationalize Products and Workflows (Months 13-18)	Apply competencies through joint products, thresholds, advisories, CSUF translation, SOPs, and workflows	Producer–user co-production pathway	Threshold matrices, trigger-action tables, sectoral advisories, CSUF/NCOF outputs, SOP drafts, DSS workflow notes, NFCS support materials
Phase 4: Institutionalize and Sustain (Months 19-24 / onwards)	Embed capacities into institutions, national systems, and long-term mechanisms	ToT pathway; institutional leadership and coordination pathway	National cascade trainings, trained trainers, institutional action plans, adopted SOPs, SKHub resources, resource mobilization products, sustainability plan

The timeline is indicative and may be adjusted based on country priorities, availability of training producers, SASCOF/CSUF schedules, funding, and operational constraints. Where feasible, activities should be aligned with existing regional and national platforms to maximize participation and reduce transaction costs.

8.1 Capacity Development Prioritization and Validation

With the broad range of technical, operational, user-oriented, and institutional competencies identified in this Framework, prioritization should be established through a staged process that would combine evidence from the TNA with country and institutional validation.

The prioritization process will begin with a preliminary review undertaken before the Phase 1 validation activity. This review will draw on findings from the TNA, Regional and National Status of Climate Services in South Asia, consultations with the SAHF Climate Services Working Group, existing national and regional capacity development initiatives, among others.

This preliminary review will produce an initial shortlist of competency areas for discussion during the Phase 1 validation activity. It will not constitute a final training programme, but provide an evidence-based starting point that nominated participants can confirm, revise, rank, and sequence according to operational needs and institutional contexts.

Prioritization Criteria

The review should consider the following criteria:

- **Capacity gap**
How significant and widespread is the identified need?
- **Operational relevance**
Will the competency improve climate-service production, delivery, or use?
- **Regional value**
Is the need shared across countries and suitable for regional action?
- **Readiness**
Are the participants, trainers, data, tools, and institutional support available?
- **Application potential**
Can the learning result in an operational product, workflow, service, or institutional improvement?
- **Feasibility and sustainability**
Can the activity be delivered, applied, and maintained with available resources?

Each proposed competency area may be rated against these criteria using a simple scale (e.g. 1= Low, 2 = Moderate, 3-High) to serve as a decision aid in prioritizing training topics. Qualitative considerations, country circumstances, sequencing requirements, and dependencies between competencies should also be taken into account.

Capacity development needs may be grouped into three indicative categories according to the following priority levels to support realistic sequencing over the implementation period:

- a) **Immediate / Core Priorities:** Competencies that address significant and widely shared gaps, are operationally urgent, and can be implemented with available technical and institutional support.

- b) **Progressive / Intermediate Priorities:** Competencies that should follow foundational training or require further preparation, data, tools, partnerships, or institutional arrangements.
- c) **Specialized / Enabling Priorities:** Advanced or context-specific competencies and enabling requirements that may require specialized participants, infrastructure investment, longer-term technical assistance, or dedicated financing.

The resulting priorities should be reviewed periodically rather than treated as fixed for the entire Framework period. The SAHF Climate Services Working Group may review them annually or after major implementation cycles, taking into account MEL findings, emerging user requirements, new tools and datasets, staff changes, and evolving regional and national priorities.

8.2 Phased Implementation

8.2.1 Phase 1: Validate and Establish the Framework (Months 1-3)

The first phase will establish the governance, coordination, competency structure, and learning systems required to implement the Framework. This phase will not be a major training delivery phase, but may include orientation sessions, technical planning workshops, partner consultations, and ToT onboarding. It will confirm which capacity needs should be addressed regionally, nationally, or institutionally and will translate the validated priorities into an indicative implementation calendar.

Key activities may include:

- Validating the Framework with the SAHF Climate Services Working Group;
- Confirming priority competencies and participant pathways;
- Mapping and consultations with training producers, RCCs, WMO RTCs, and technical partners;
- Developing an indicative regional training calendar;
- Identifying priority countries, institutions, and participant groups;
- Establishing the ToT pool;
- Preparing SKHub learning pathways;
- Aligning the Framework with CS WG work plan priorities;
- Coordinating with other SAHF working groups; and
- Identifying priority modules for trainings, producer-user workshops, and technical clinics.

Expected outputs may include a finalized framework document, competency matrix, training calendar, partner mapping, ToT candidate list, SKHub learning structure, and initial module outlines.

Table 9. Summary of Proposed Implementation for Phase 1

Training / Capacity Development Activity	Delivery Method	Target Participants	Expected Outputs
Framework validation and implementation planning workshop	Hybrid / virtual consultation	SAHF CS WG members, NMHS focal points, regional partners, selected user sector representatives	Validated implementation approach and priority activities
Competency and participant pathway mapping	Virtual working session / technical consultation	NMHS focal points, user sector focal points, training coordinators	Competency matrix and participant pathway mapping
Training producer and resource person mapping	Virtual coordination meetings	SAHF, RCCs, WMO RTCs, regional technical partners	Partner roster and module-producer mapping
ToT pool identification and orientation	Virtual orientation	Prospective ToT candidates from NMHSs, user sectors, training institutions	ToT candidate list and ToT learning pathway
SKHub learning pathway design	Technical working session	SAHF/RIMES, training producers, knowledge management focal points	SKHub course structure, module templates, initial repository

8.2.2 Phase 2: Deliver Core Competency Training (Months 4-12)

Phase 2 will deliver the core technical and applied training modules for producers and user sector institutions. This phase will focus on building foundational and advanced competencies required for operational climate services across S2S, seasonal, decadal, and climate change timescales.

Key training areas may include:

- Climate data management and quality control;
- Regional gridded datasets;
- S2S and seasonal forecasting;
- NWP and climate model interpretation;
- Downscaling and bias correction;
- Forecast verification;
- IT skills for meteorologists;
- Forecast interpretation and translation for user sectors;
- Communication of uncertainty;
- Climate information dissemination.

Expected outputs may include trained producer and user cohorts, completed technical modules, draft workflows, practical tools, datasets, scripts, advisory templates, and participant learning assessments.

Table 10. Summary of Proposed Implementation for Phase 2

Training Topic / Module	Delivery Method	Target Participants	Expected Outputs
Climate data quality management, data handling, metadata, and modern quality control techniques	In-person / hybrid technical training; data clinic	NMHS data managers, climate analysts, climate service officers, GIS/IT staff	Draft QC workflow, data handling checklist, metadata guidance
Development and use of regional gridded observation datasets	Hands-on data laboratory / technical clinic	NMHS climate analysts, RCC staff, GIS/IT personnel	Gridded dataset use cases, validation exercises, guidance note
Integration of satellite and ground observation datasets	Hands-on technical training / case-based exercises	NMHS climate analysts, data managers, GIS specialists	Example integrated datasets, monitoring or verification use case
S2S and seasonal forecasting, including interpretation of multi-model ensemble products	RCC-led technical training / pre-SASCOF training	NMHS forecasters, climate service officers, RCC staff	Forecast interpretation exercises, country-level product assessment
NWP and climate model interpretation, downscaling, and bias correction	In-person / hybrid technical training	NMHS forecasters, modelers, climate analysts	Model interpretation workflow, downscaling or bias correction exercise
Forecast verification, skill assessment, and climate diagnostics	Technical clinic / hands-on training	NMHS forecasters, climate analysts	Verification outputs, skill assessment workflow
IT skills for meteorologists, including scripting, automation, visualization, database management, and digital platform use	Week-long hands-on training / secondment option	NMHS technical staff, GIS/IT personnel, data managers	Scripts, dashboards, automated workflows, visualization products
Forecast interpretation and translation for user sectors	producer–user workshop / CSUF-linked training	Agriculture, DRR, water, health, energy, planning, humanitarian and other user sectors	Sectoral interpretation guide, decision calendar, user feedback template
Climate information dissemination and communication of uncertainty	Hybrid workshop / communication clinic	NMHS climate service officers, communication staff, user sector focal points	Draft dissemination plan, advisory communication template

8.2.3 Phase 3: Operationalize Products and Workflows (Months 13-18)

The third phase will focus on translating competencies into operational products, workflows, and institutional applications. Training in this phase will be applied and output-oriented. This phase should be strongly linked to SASCOF, CSUF, NCOFs, and sectoral planning processes.

Key activities may include:

- Developing and testing sectoral thresholds;
- Preparing trigger-action matrices;
- Co-developing sectoral advisories;
- Supporting CSUF-linked producer-user translation sessions;
- Conducting NCOFs;
- Integrating climate information into DSS workflows;
- Developing SOPs for production, dissemination, and feedback;
- Preparing NFCS support package materials;
- Conducting mid-season review sessions;
- Documenting post-season learning.

Expected outputs may include advisory prototypes, threshold matrices, dissemination plans, SOP drafts, DSS workflow notes, NFCS support materials, CSUF outputs, National Outlook Forum materials, and documented seasonal learning products.

Table 11. Summary of Proposed Implementation for Phase 3

Training / Capacity Development Activity	Delivery Method	Target Participants	Expected Outputs
Threshold development, attribution, historical impact analysis, and validation	producer–user workshop / technical clinic	NMHSs, DRR, agriculture, water, health, RCCs, sector agencies	Draft threshold matrices, impact pathways, validation notes
Trigger-action matrix development for S2S and seasonal climate information	Simulation exercise / co-production workshop	NMHSs, user sector agencies, anticipatory action actors	Trigger-action tables, early action options
CSUF operationalization package and producer–user translation cycle	CSUF-linked workshop / facilitated translation sessions; combination of virtual consultations / sessions, SKHub modules, and in-person sessions	NMHSs, RCCs, user sectors, CSUF/NCOF coordinators	Sectoral implication notes, advisory inputs, user feedback summary
Sectoral advisory co-production	Case-based design workshop	NMHS climate service officers, agriculture, DRR, water, health, energy, planning sectors	Draft sectoral advisories and product templates
SOP development for climate service production,	Institutional workshop / technical clinic	NMHS managers, climate service units, communication	Draft SOPs and service delivery workflows

dissemination, feedback, and review		officers, user sector focal points	
DSS workflow integration	Technical clinic / institutional workshop	NMHSs, DSS/IT staff, user sector operational units	DSS workflow notes, integration plan
NFCS support package development	Institutional planning workshop	NMHS leadership, NFCS focal points, planning officers, user sector institutions	NFCS support package outline, coordination templates, roadmap
Mid-season review and post-season learning review	Virtual review / hybrid learning session	NMHSs, user sectors, CSUF/NCOF participants	Review notes, lessons learned, updates for next cycle

8.2.4 Phase 4: Institutionalize and Sustain (Months 19-24)

The fourth phase will focus on institutionalizing capacities, products, and mechanisms beyond the project timeline. Training in this phase will focus on ToT, cascade training, institutional planning, peer learning, sustainability, and resource mobilization.

Key activities may include:

- Supporting national cascade trainings;
- Strengthening national training pathways;
- Formalizing institutional workflows and SOPs;
- Integrating outputs into NMHS and user sector processes;
- Conducting exposure visits and country-to-country learning;
- Maintaining periodic training cycles;
- Updating SKHub resources;
- Reviewing MEL findings and adapting the Framework;
- Strengthening linkages with NFCS, RFCS, SASCOF, CSUF, and SAHF working groups.

Expected outputs may include national training modules, trained national trainers, institutional action plans, adopted SOPs, sustained SKHub learning pathways, regional communities of practice, and evidence of continued capacity development beyond the initial project cycle.

Table 12. Summary of Proposed Implementation for Phase 4

Training / Capacity Development Activity	Delivery Method	Target Participants	Expected Outputs
Full Training-of-Trainers workshop	In-person / hybrid ToT	Selected ToT candidates from NMHSs, user sectors, training institutions	Trained trainers, adapted modules, facilitation plans
National cascade trainings	National in-person / hybrid trainings	NMHS staff, user sector institutions, sub-national stakeholders	Cascade training reports, expanded trained cohort
Institutional competency and training pathway workshop	Institutional planning workshop	NMHS managers, training coordinators, NFCS focal points	Institutional training pathway, competency framework outline
Exposure visits and country-to-country learning	Exposure visit / peer exchange	NMHSs, user sector institutions, ToT graduates, institutional focal points	Learning notes, institutional action points, peer exchange outputs
Refresher trainings and advanced technical clinics	RCC-led refresher / virtual clinic	NMHS technical staff, ToT graduates	Refreshed skills, updated workflows, technical troubleshooting notes
Resource mobilization and decision-maker engagement	Institutional workshop / policy briefing	NMHS leadership, planners, finance/project staff, decision-makers	Concept notes, investment briefs, climate services value narrative
SKHub update and learning package finalization	Technical working session	SAHF/RIMES, ToT graduates, training producers	Final modules, recordings, templates, case studies, learning products
Framework review and next-cycle planning	Regional review workshop	SAHF CS WG, NMHSs, RCCs, user sectors, partners	MEL synthesis, updated training calendar, next-cycle priorities

8.3 Training-of-Trainers Implementation

The ToT track will be implemented as a cross-cutting mechanism across the Framework. It will begin during Phase 1 through identification and orientation of ToT candidates, continue through Phase 2 and Phase 3 through co-facilitation and mentoring, and culminate in Phase 4 through full ToT training, national cascading, and institutionalization.

The purpose of the ToT track is to develop a pool of national and regional trainers who can adapt, facilitate, and replicate training modules within their institutions and countries. ToT is also intended to reduce dependence on external trainers, strengthen institutional memory, and support continuity despite staff turnover and resource limitations.

Table 13. Proposed Timeline for TOT Implementation

Timeline	ToT Component	Delivery Method	Expected Outputs
Months 1–3	ToT pool identification and orientation	Virtual orientation	ToT pool identified; roles and expectations clarified
Months 4–10	Participation in core competency trainings	Embedded in Phase 2 trainings	Technical grounding in selected competency pillars
Months 8–12	Assisted facilitation and observation	Co-facilitation / mentoring	Initial facilitation exposure; reflection notes
Months 13–18	Co-facilitation of applied workshops, CSUF-linked sessions, threshold development, and advisory co-production	Embedded co-facilitation	ToT candidates support applied sessions and documentation
Months 19–21	Full ToT workshop: facilitation, training design, module adaptation, evaluation, and cascade planning	In-person / hybrid ToT	Adapted modules, facilitation plans, cascade training plans
Months 20–24	National cascade training and mentoring	National training / hybrid delivery	National cascade trainings conducted; reports prepared
Beyond Month 24	Community of practice and continued support	SKHub, periodic clinics, mentoring	Continued trainer network; updated modules; sustained capacity development

The ToT sessions shall cover the following topics:

- adult learning principles and facilitation techniques;
- training design and session planning;
- adapting regional modules to national and sectoral contexts;
- use of case studies, datasets, tools, and practical exercises;
- facilitation of technical and producer–user sessions;
- managing mixed participant groups, including producers and users;
- integrating GESI and inclusive participation in training delivery;
- use of SKHub materials and facilitator guides;
- pre/post assessment design and participant feedback;
- documentation and reporting of cascade trainings;
- mentoring and peer learning.

9 ROLES AND COORDINATION ARRANGEMENTS

The Framework will require clear coordination among SAHF, regional partners, NMHSs, and user sector institutions. Its success will depend on how well capacity development is linked with operational priorities, regional mechanisms, and institutional responsibilities.

9.1 SAHF Climate Services Working Group

The SAHF Climate Services Working Group will provide strategic guidance and regional coordination for the Framework.

Its roles may include:

- Validating and periodically updating the Framework;
- Identifying priority capacity development needs;
- Aligning training activities with the CS WG work plan;
- Supporting nomination of participants and ToT candidates;
- Coordinating with RCCs, WMO RTCs, and technical partners;
- Facilitating linkages with SASCOF, CSUF, NCOFs, and SKHub;
- Reviewing training outputs and institutional uptake;
- Promoting learning exchange among NMHSs and user sector institutions;
- Ensuring coordination with other SAHF working groups.

The CS WG should also help ensure that the Framework remains demand-driven and responsive to evolving regional and country needs.

9.2 Regional Technical Partners

Regional technical partners will provide specialized expertise, training support, mentoring, and technical backstopping.

Their roles may include:

- Delivering RCC-led and regional technical trainings;
- Supporting training on seasonal forecasting, S2S, NWP, modelling, downscaling, verification, and gridded datasets;
- Providing technical guidance on data quality management and data-sharing workflows;
- Hosting exposure visits or secondments;
- Supporting development of training modules and practical exercises;
- Providing mentoring and technical clinics;
- Contributing to SKHub materials;
- Supporting quality assurance of technical outputs.

Potential partners may include RCC Pune, WMO, WMO RTCs, RIMES, UKMO, IITM, NCMRWF, ECMWF, ESCAP, ICIMOD, RCCC, WFP, IWMI, and other relevant institutions.

9.3 NMHSs

NMHSs will be the primary national institutions responsible for climate service production, coordination, and delivery.

Their roles may include:

- Nomination appropriate participants and ToT candidates;
- Identification of national competency needs;
- Participation in technical trainings, producer-user workshops, and CSUF-linked activities;
- Application of training outputs within operational workflows;
- Development or strengthening of SOPs, advisories, dissemination processes, and feedback mechanisms;
- Support to national cascade trainings;
- Coordination with user sector institutions;
- Contribution to data, case studies, and country experiences;
- Support to NCOFs and NFCS-related processes;
- Documentation of application of learning and institutional uptake.

NMHSs should be encouraged to nominate both technical staff and institutional focal points to ensure that learning is translated into operational and organizational improvements.

9.4 User Sector Institutions

User sector institutions will play a central role in ensuring that climate services are relevant, understandable, and actionable.

Their roles may include:

- Participation in forecast interpretation and translation training;
- Identification of sectoral decision calendars, thresholds, and information needs;
- Co-development of advisories, trigger-action matrices, and early action guidance;
- Participation in CSUF, NCOFs, and feedback processes;
- Application of climate information in sectoral planning, preparedness, and operations;
- Support in disseminating climate information within their institutions and networks;
- Provision of feedback on the usability and relevance of climate products;
- Participation in ToT or national cascading where appropriate.

Priority user sectors may include agriculture, DRR, water resources, health, energy, transport, infrastructure, humanitarian action, planning, environment, and local government.

9.5 Coordination with other SAHF Working Groups

The Framework will maintain clear coordination with other relevant SAHF working groups. This is important because several capacity development priorities—such as thresholds, early action, DSS workflows, data systems, hydrological applications, and sectoral advisories—cut across multiple workstreams.

Coordination may include:

- Joint planning of training activities;

- Shared modules on thresholds, early action, DSS, and risk communication;
- Harmonized terminology and methods;
- Joint technical clinics;
- Cross-review of SOPs, thresholds, advisory templates, and DSS workflows;
- Shared use of case studies and datasets;
- Alignment of climate services and IBF activities across timescales;
- Coordination of producer–user engagement through CSUF and related platforms.

This coordination will help avoid duplication and ensure that climate services capacity development supports broader SAHF priorities.

10 MONITORING, EVALUATION, LEARNING, AND ADAPTATION

MEL and Adaptation will be embedded throughout the Framework. The purpose is not only to track training delivery, but to assess whether capacity development contributes to improved climate service production, dissemination, translation, application, and institutionalization. The MEL system should assess progress across the following dimensions:

MEL Dimension	Focus
Input and process monitoring	Trainings conducted, partners engaged, resources developed, modalities used
Participation	Number and profile of participants by country, institution, gender, role, and sector
Learning outcomes	Knowledge, skills, confidence, and competency improvements
Application outcomes	Use of tools, workflows, datasets, advisories, thresholds, and products
Institutional uptake	Integration into SOPs, DSS, NFCS processes, data-sharing protocols, and workflows
producer–user engagement	Functionality of CSUF, National Outlook Forums, feedback loops, and co-production processes
Sustainability	ToT, national cascading, SKHub use, mentoring, RCC-led periodic trainings
Adaptation	Adjustments made to training design based on feedback and emerging needs

Indicative indicators may include:

- Number of regional trainings conducted beyond pre-COF sessions;
- Number of producer-user learning workshops conducted;
- Number of technical clinics, mentoring sessions, exposure visits, or secondments conducted;
- Number of participants completing SKHub modules;
- Number of ToT participants trained and involved in cascade delivery;
- Number of national or sub-national cascade trainings conducted;
- Number of SOPs, advisory templates, threshold matrices, trigger-action tables, and workflows produced;
- User feedback on clarity, usability, relevance, and timeliness of climate services;
- Documented learning from mid-season and post-season reviews.

Learning should be reviewed after each major training cycle, CSUF cycle, or implementation phase. Findings should be used to refine modules, update training priorities, improve delivery approaches, and strengthen institutionalization.

11 SUSTAINABILITY AND LONG-TERM CAPACITY DEVELOPMENT

Sustainability is central to the Regional Training Framework. The Framework is designed to move capacity development beyond one-off training events and project-bound activities toward a continuing regional system for strengthening climate services capacity in South Asia.

Long-term capacity development will be supported through the institutionalization of competencies, periodic regional training, Training-of-Trainers, national cascading, SKHub-based learning, peer exchange, exposure visits, mentoring, and continued coordination through SAHF mechanisms. These approaches will help ensure that knowledge and skills are retained, adapted, and applied within NMHSs, user sector institutions, and regional platforms beyond the immediate project timeline.

11.1 Institutionalization of Competencies

The Framework will support the integration of climate services competencies into institutional systems and workflows. Training outputs should not remain at the level of individual learning but should contribute to operational improvements within NMHSs and user sector institutions.

This may include the development or strengthening of:

- climate services competency frameworks;
- standard operating procedures;
- data quality management workflows;
- gridded dataset development processes;
- forecast verification and advisory development workflows;
- threshold matrices and trigger-action guidance;
- user engagement and feedback mechanisms;
- NFCS support materials;
- decision-support system workflows;
- national training pathways.

11.2 Training-of-Trainers and National Cascading

The ToT approach will be a key mechanism for scaling and sustaining the Framework. Selected participants from NMHSs, RCCs, user sector institutions, training centres, and partner organizations will be supported to adapt, facilitate, and replicate training modules at national and sub-national levels.

ToT participants will be expected to support cascade trainings, co-facilitate regional and national sessions, contribute to SKHub resources, and mentor other participants. This will reduce dependence on external trainers and help build a pool of national and regional resource persons for climate services capacity development.

11.3 Periodic Regional Capacity Building

The Framework will promote periodic capacity building through RCCs, WMO Regional Training Centres, SAHF mechanisms, and regional technical partners. This responds directly to the need identified by the Climate Services Working Group for more frequent training beyond pre-COF sessions.

Periodic training may include refresher courses, technical clinics, regional data laboratories, model interpretation sessions, user sector workshops, and short-term secondments. These activities will help maintain and update capacities as climate service tools, datasets, methods, and user needs evolve.

11.4 SKHub as a Long-Term Learning Platform

The SAHF Knowledge Hub will serve as the Framework's long-term knowledge management and learning platform. It will support pre-learning, post-training reinforcement, ToT, national cascading, and institutional memory.

SKHub may host training modules, recorded sessions, datasets, exercises, advisory templates, SOP examples, threshold development tools, NFCS support materials, CSUF resources, learning reviews, and case studies. Over time, SKHub should function as a regional repository for climate services capacity development resources.

11.5 Peer Learning, Exposure Visits, and Country-to-Country Exchange

Exposure visits and country-to-country learning will support practical peer learning across South Asia. These activities will allow NMHSs and user sector institutions to learn from countries or institutions with operational experience in areas such as gridded datasets, climate data quality management, seasonal forecasting, CSUF/NCOF processes, threshold development, dissemination systems, DSS, and NFCS implementation.

Each exposure visit should have clear learning objectives, expected outputs, and post-visit knowledge-sharing requirements. Outputs may include learning notes, institutional action points, presentations to the CS WG, or resources for SKHub.

11.6 Partnerships and Resource Mobilization

Sustainability will depend on continued collaboration with regional and international partners. RCCs, WMO, RIMES, UKMO, World Bank, ESCAP, ICIMOD, ECMWF, IITM, NCMRWF, RCCC, WFP, IWMI, and other partners may support training delivery, mentoring, technical clinics, secondments, resource development, and knowledge sharing.

The Framework will also support sustainability by strengthening the enabling capacities needed for resource mobilization and long-term institutional support. This includes helping NMHSs and relevant national institutions better articulate climate services priorities, document capacity needs, prepare concept notes or investment briefs, and align proposed initiatives with funding opportunities from multilateral banks, development partners, non-government organizations, and other financing mechanisms.

In parallel, the Framework will support the development of evidence products that help national decision-makers appreciate the value of climate services as an investment in risk reduction,

preparedness, adaptation, and resilient development. These may include case studies, impact stories, policy briefs, cost-benefit narratives, and decision-maker briefings that show how climate services contribute to public planning, protect lives and livelihoods, reduce losses, and improve the effectiveness of sectoral investments.

By strengthening these capacities, the Framework can help create a more enabling environment for sustained financing. This will support the gradual integration of climate services initiatives into national budgets, institutional plans, and partner-supported programmes, reducing reliance on short-term project financing over time.

11.7 Long-Term Outcomes

Over the long term, the Framework is expected to contribute to:

- strengthened technical and institutional capacity of NMHSs;
- improved ability of user sectors to interpret and apply climate information;
- more regular and coordinated regional capacity building;
- stronger producer–user engagement through CSUF, NCOFs, and related mechanisms;
- improved data management, forecasting, advisory development, dissemination, and feedback workflows;
- greater institutionalization of climate services within NFCS, SOPs, DSS, and sectoral planning systems;
- sustained regional cooperation and peer learning across South Asia.

ACRONYMS

CARA	Climate Action for a Resilient Asia
COF	Climate Outlook Forum
CS	Climate Services
CSUF	Climate Services User Forum
DataEx	Data Exchange Platform
DSS	Decision Support System
EAP	Early Action Protocol
ECMWF	European Centre for Medium-Range Weather Forecasts
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
FCDO	Foreign, Commonwealth & Development Office
GFCS	Global Framework for Climate Services
GIS	Geographic Information System
IBF	Impact-Based Forecasting
ICIMOD	International Centre for Integrated Mountain Development
ICT	Information and Communications Technology
IITM	Indian Institute of Tropical Meteorology
IWMI	International Water Management Institute
MEL	Monitoring, Evaluation, and Learning
NCMRWF	National Centre for Medium Range Weather Forecasting
NCOF	National Climate Outlook Forum
NFCS	National Framework for Climate Services
NMHS	National Meteorological and Hydrological Service
NWP	Numerical Weather Prediction
QC	Quality Control
RCC	Regional Climate Centre
RCCC	Red Cross Red Crescent Climate Centre
RFCS	Regional Framework for Climate Services
RIMES	Regional Integrated Multi-Hazard Early Warning System
SAHF	South Asia Hydromet Forum
SASCOF	South Asian Climate Outlook Forum
SKHub	SAHF Knowledge Hub
SOP	Standard Operating Procedure
S2S	Sub-seasonal to Seasonal
ToT	Training-of-Trainers
UKMO	United Kingdom Met Office
WFP	World Food Programme
WISER	Weather and Climate Information Services for Asia and the Pacific Programme
WMO	World Meteorological Organization