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Knowledge Ecosystems for Scientific Communication and Public Understanding

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ABSTRACT

Scientific communication operates within wider systems of knowledge generation, preservation, translation, access and participation. This paper develops the concept of a knowledge ecosystem to examine how knowledge-transfer mechanisms have evolved from oral and cultural traditions to manuscripts, libraries, print, broadcast, digital networks and AI-enabled environments. It brings together literature on intangible cultural heritage, science communication, open science, libraries, citizen science and digital preservation with documented professional and field-based experiences associated with the authors. Particular attention is given to cultural mechanisms of transmission, Hindi-language science communication, community libraries and selected Rajasthan experiences involving biodiversity conservation, water management, ecological restoration and community participation. The paper proposes an Integrated Knowledge Ecosystem Framework (IKEF) comprising Generation, Preservation, Curation, Translation, Communication, Participation, Application, Scaling and Feedback. A complementary Community Knowledge Interface Model is proposed for libraries: Preserve, Curate, Connect, Translate, Enable, Engage and Feedback. These models are conceptual syntheses rather than empirically validated pre-existing frameworks. The analysis also distinguishes information access from understanding, participation from validation, and local knowledge scaling from automatic replication. It argues that libraries and science communicators can serve as interfaces among scientific, cultural, local, institutional and digital knowledge environments, while AI and digital technologies should be treated as enabling infrastructure requiring verification, ethical governance and human mediation.

INTRODUCTION

Knowledge has always been transmitted through oral, cultural, institutional and technological mechanisms. Long before contemporary scientific journals, databases and digital platforms, communities developed systems for preserving observations, practices, memories and understandings across generations. Oral traditions, folklore, songs, dance, visual arts, manuscripts and libraries each provided mechanisms through which knowledge could be retained and communicated (UNESCO, 2003). Modern scientific communication adds another layer to this historical continuum. Scientific knowledge may be highly specialised, yet its social value often depends on whether it can be interpreted and communicated beyond specialist communities. This makes translation, contextualisation and mediation central to public understanding of science (Reincke et al., 2020).

The Indian context is especially relevant because scientific communication is connected with the constitutional ideal of developing scientific temper, humanism and the spirit of inquiry and reform (Constitution of India, 1950). At the same time, India's cultural diversity has produced numerous mechanisms through which environmental observations, social memory and practical knowledge have been transmitted.

Community libraries represent an important contemporary interface within this landscape. They

can provide access to scientific literature, educational resources, cultural material and digital information while also creating local spaces for learning and interaction (International Federation of Library Associations and Institutions, 2025).

Documented scientific communication work and library/information-science practice provide complementary perspectives for examining this relationship. The authors' professional records document extensive scientific and popular communication, including scientific and popular articles, Hindi field guides, presentations, invited lectures, training and public environmental engagement. This paper therefore examines how knowledge ecosystems connect knowledge generation, preservation, curation, translation, communication, participation, application and feedback.

The principal research questions are

- How have knowledge-transfer mechanisms evolved from oral and cultural traditions to institutional, mass-media, digital and AI-enabled systems?
- How do folklore, folk songs, dances, visual arts and community practices contribute to intergenerational knowledge transmission?
- How can scientific and environmental knowledge be translated into accessible public communication?
- How can community libraries function as knowledge

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interfaces between scientific knowledge, cultural memory, digital resources and public learning?

The paper aims to develop an Integrated Knowledge Ecosystem Framework for Scientific Communication and Public Understanding.

LITERATURE REVIEW

Knowledge Ecosystems and Knowledge Transfer

Knowledge does not circulate through a single institutional or technological channel. It moves through interconnected social, cultural, institutional and technological environments in which knowledge may be generated, preserved, interpreted, communicated, accessed and applied. Science communication literature has increasingly moved beyond a simple deficit model in which experts transmit information to passive publics, toward approaches that recognise dialogue, interaction and the roles of different actors in communication processes (Reincke et al., 2020).

The present study uses the term knowledge ecosystem to describe this interconnected environment. The concept extends beyond the conventional information-system emphasis on storage, retrieval and dissemination by incorporating interpretation, participation, application and feedback. Within such an ecosystem, scientists, knowledge institutions, communities, cultural knowledge holders, communicators, libraries, publics and digital platforms may occupy interconnected positions.

The distinction between knowledge circulation and knowledge validation is important. Information can be widely communicated without necessarily being scientifically validated, while participation can generate observations and experiences that require appropriate assessment before they are used as scientific evidence. This distinction is particularly relevant to citizen science, where data quality, identification procedures, metadata and validation influence the usefulness of public contributions (Aceves-Bueno et al., 2015; Balázs et al., 2021).

The knowledge-ecosystem perspective therefore provides a basis for examining scientific communication not simply as dissemination, but as a process involving multiple interfaces among knowledge producers, institutions, communities and publics.

Oral, Cultural and Traditional Knowledge

Knowledge transmission predates contemporary scientific journals, digital repositories and formal information systems. Oral traditions, performing arts, social practices, rituals and knowledge concerning nature and the universe represent forms through which knowledge and cultural memory can be transmitted across generations (UNESCO, 2003).

Such systems may preserve observations concerning landscapes, species, water, weather, vegetation, agriculture, livelihoods and seasonal cycles within cultural practices and social memory. Their significance for the present study lies not in treating traditional or cultural knowledge

as equivalent to scientific knowledge, but in recognising that knowledge may be generated and transmitted through different epistemic and social processes.

This distinction is particularly important when cultural knowledge becomes incorporated into contemporary communication systems. Documentation can increase accessibility, but it can also remove knowledge from its original social and cultural context. Questions of attribution, consent, community participation and appropriate stewardship therefore become relevant when cultural and community knowledge is documented or digitally circulated (UNESCO, 2003).

The literature consequently supports an approach in which local and cultural knowledge can enter dialogue with scientific knowledge while retaining distinctions concerning their origins, methods and modes of validation.

Scientific Communication and Public Understanding

Scientific communication involves more than making scientific information publicly available. The movement from specialist knowledge to public understanding requires selection, interpretation, contextualisation, translation and presentation for different audiences. Reincke et al. (2020) describe the limitations of a purely deficit-oriented approach and emphasise the importance of dialogue and additional roles for scientists and other participants in communication.

This perspective is relevant to environmental and biodiversity communication because scientific information frequently needs to be translated into forms that can be understood and used by people with different educational, linguistic and experiential backgrounds. Vernacular communication, field guides, public lectures, environmental education, exhibitions, media engagement and participatory activities can therefore operate as different communication interfaces.

The Indian context adds a further dimension through the constitutional recognition of scientific temper, humanism and the spirit of inquiry and reform (Constitution of India, 1950). Scientific communication and scientific temper should nevertheless not be treated as synonymous. Communication concerns the circulation and interpretation of scientific knowledge, whereas scientific temper represents a broader orientation toward inquiry, evidence, questioning and rational examination.

The literature therefore supports distinguishing communication, understanding, participation and scientific validation rather than treating them as interchangeable outcomes.

Libraries as Knowledge Interfaces

Libraries have traditionally provided mechanisms for collecting, organising, preserving and providing access to knowledge. Contemporary digital environments have expanded these functions by introducing electronic resources, networked information, digital repositories and new forms of information discovery.

The development of artificial intelligence introduces another layer to this transformation. Current library guidance identifies potential applications of AI in information and knowledge environments while also emphasising responsible, inclusive and ethical use (IFLA Artificial Intelligence SIG, 2024; International Federation of Library Associations and Institutions, 2025). Recent E-Palli research on a digital learning platform for rural local-government personnel similarly illustrates the importance of structured digital training, user competence and human support when digital tools are introduced into local institutional practice (Agraan et al., 2025).

Within the present conceptualisation, a community library can therefore be considered a potential knowledge interface rather than merely a repository. Such an interface may connect local users with scientific literature, cultural resources, digital information, community documentation, learning opportunities and wider knowledge networks.

The interface concept also extends the role of the library toward curation, translation, connection, engagement and feedback. However, these functions are presented as potential ecosystem roles rather than as characteristics automatically possessed by every community library.

Digital, Open and Participatory Knowledge Environments

Digital technologies have changed the scale and speed of knowledge circulation. Digital repositories can facilitate preservation and access, multimedia platforms can combine text, image, audio and video, and networked systems can connect geographically separated communities.

Open science extends this transformation by promoting broader access to scientific knowledge, participation of societal actors and dialogue among different knowledge systems (UNESCO, 2021). These developments are relevant to public understanding because access to information can create opportunities for learning and participation, although access alone does not guarantee comprehension or appropriate use.

Citizen science provides an important example of participatory knowledge production. Members of the public may contribute observations, photographs and measurements, but the scientific usefulness of such contributions depends on appropriate procedures for data quality and validation (Aceves-Bueno et al., 2015; Balázs et al., 2021).

Artificial intelligence can further support discovery, translation, summarisation, accessibility and metadata-related functions. At the same time, AI-mediated information requires attention to provenance, accuracy, context, verification and ethical governance (IFLA Artificial Intelligence SIG, 2024; International Federation of Library Associations and Institutions, 2025).

Digital preservation is similarly important because digital information can become inaccessible through technological obsolescence, broken links, platform dependence or loss of contextual metadata. Preservation

and openness therefore need to be considered together with responsible stewardship.

Literature Gap

The literature considered in this study addresses several components of knowledge communication separately, including intangible cultural heritage, science communication, open science, libraries, citizen science and digital preservation. These bodies of work demonstrate the importance of access, communication, participation and preservation, but their relationships are often examined through separate disciplinary perspectives.

The present synthesis identifies a need to examine these functions as an interconnected knowledge ecosystem, particularly at the interface among scientific knowledge, local and cultural knowledge, community libraries, public communication and emerging digital technologies. The objective is not to claim that these relationships have been entirely absent from previous scholarship, but to bring their complementary functions together within a single conceptual structure.

The resulting Integrated Knowledge Ecosystem Framework therefore connects knowledge generation, preservation, curation, translation, communication, participation, application, scaling and feedback while retaining distinctions between knowledge circulation, interpretation, participation and validation.

MATERIALS AND METHODS

Research Approach

This study adopts a documentary and conceptual synthesis approach to examine knowledge ecosystems for scientific communication and public understanding. The analysis brings together literature and documentary sources concerning intangible cultural heritage, science communication, open science, libraries, citizen science, digital preservation and emerging digital and artificial-intelligence-enabled knowledge environments. The study does not constitute a systematic review, experimental investigation, survey or quantitative evaluation. Its purpose is to synthesise relevant evidence and documented experiences into a conceptual framework for understanding relationships among different knowledge-transfer functions.

Documentary and Literature Sources

The evidence base comprises published scholarly literature, institutional and international-organisation documents, library and information-science resources, public knowledge platforms, environmental documentation and selected records of professional and field-based communication activities. Sources were examined for their relevance to knowledge generation, preservation, curation, translation, communication, participation, application and scaling. Particular attention was given to sources documenting science communication and public dialogue; intangible and cultural knowledge; open science; library and information services; citizen science

and data quality; digital and documentary preservation; environmental education; community participation; Hindi-language science communication; and documented environmental and biodiversity experiences in Rajasthan.

Analysis of Documented Experiences

Selected Indian and Rajasthan experiences were used as illustrative cases to examine how environmental and community knowledge can move from local experience toward documentation, institutional mediation, public communication and wider knowledge exchange. These include documented experiences associated with Abu Hills, Bharatpur and Project Boond, Dholpur, Kumbhalgarh and Keoladeo/Bharatpur, together with Hindi field guides, public knowledge platforms and environmental education and citizen-engagement activities. The Abu Hills material documents a conservation-and-livelihood approach involving the Green Avadavat, local youth, nature guiding and community participation (Mehra, 2023). Project Boond provides a documented example of community-oriented water conservation (Mehra, 2012), while the Dholpur study provides documentation concerning wetlands and environmental conditions in the district (Mehra & Mehra, 2013). Keoladeo-related work provides an additional example linking biodiversity, water and landscape concerns with documentation and public knowledge resources (Mehra & Mehra, 2014; Mehra, 2016). These cases are treated as contextual examples rather than controlled evaluations of outcomes. The analysis therefore does not infer causal effects on scientific literacy, scientific temper, conservation behaviour or livelihood outcomes from the documented activities.

Conceptual Synthesis

The analysis identified recurring functions and interfaces across the documentary material and organised them into an Integrated Knowledge Ecosystem Framework (IKEF). The framework comprises nine interconnected functions: Generation, Preservation, Curation, Translation,

Communication, Participation, Application, Scaling and Feedback. Feedback connects application and scaling to renewed knowledge generation. A complementary Community Knowledge Interface Model was developed to describe potential functions of community libraries: Preserve, Curate, Connect, Translate, Enable, Engage and Feedback. The synthesis also distinguishes five interacting knowledge domains: Scientific knowledge; Local and experiential knowledge; Cultural knowledge; Institutional knowledge; Digital and technological knowledge environments. These domains are treated as interacting but not interchangeable.

Analytical Boundaries

Several analytical boundaries were established to avoid overinterpretation. First, knowledge circulation is distinguished from knowledge validation. Wider dissemination does not itself establish scientific validity. Second, information access is distinguished from understanding and scientific temper. Access to a resource does not demonstrate comprehension or a disposition toward evidence-based inquiry. Third, participation is distinguished from validation. Public participation can contribute observations, experiences and feedback, but these contributions may require appropriate assessment. Fourth, knowledge scaling is distinguished from automatic replication. A locally developed approach may provide transferable principles while requiring adaptation to different ecological, social and institutional contexts. Finally, the proposed IKEF and Community Knowledge Interface Model are treated as conceptual syntheses rather than empirically validated causal models. The Rajasthan experiences are used to illustrate possible knowledge pathways and not to establish universal effects.

RESULTS AND DISCUSSION

From Oral Traditions to Digital Knowledge

Knowledge-transfer mechanisms have changed substantially in medium while retaining important

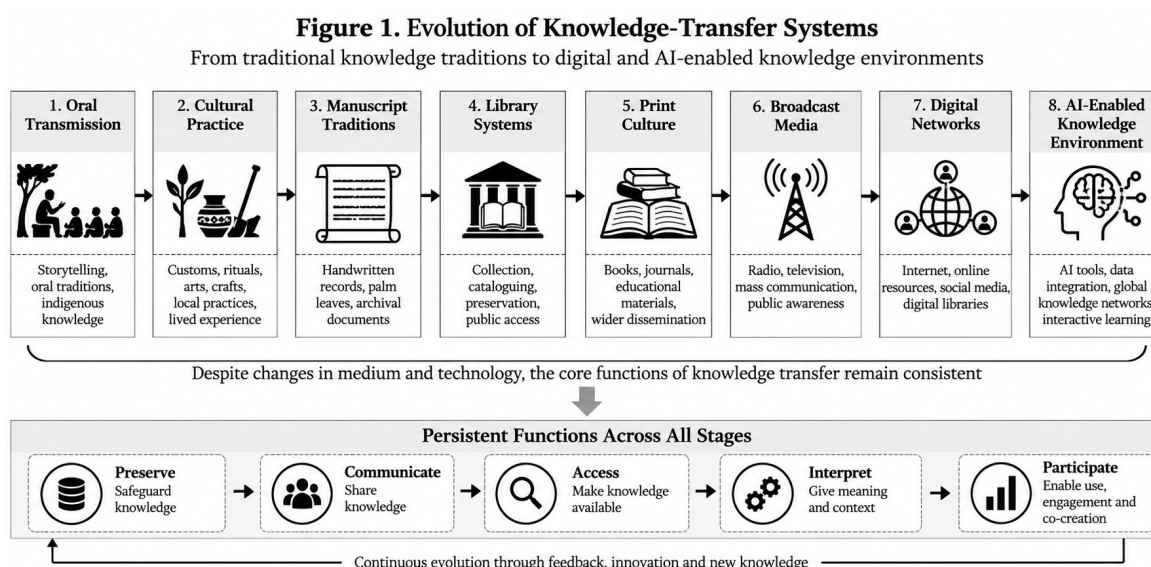


Figure 1: Evolution of Knowledge-Transfer Systems

continuities in social function. A historical continuum can be represented as: Oral transmission → cultural practice → manuscript traditions → library systems → print culture → broadcast media → digital networks → AI-enabled knowledge environment.

Oral traditions provide mechanisms for transmitting narratives, expressions, memories and knowledge across generations. Intangible cultural heritage includes oral traditions and expressions, performing arts, social practices, rituals and festive events, and knowledge concerning nature and the universe (UNESCO, 2003). Manuscripts and libraries introduced more durable institutional forms of preservation and access. Print expanded circulation, while radio and television broadened mass communication. Digital systems subsequently introduced searchable repositories, networked access and multimedia communication. Contemporary AI-enabled environments add potential functions in discovery, translation, summarisation and accessibility.

The historical progression is illustrated in Figure 1.

Cultural Mechanisms of Knowledge Transmission

Cultural mechanisms are important components of knowledge ecosystems because they provide socially embedded ways of transmitting memory, observation, values, practices and understandings. Folklore can encode environmental memories and social experience. Folk songs can preserve narratives and place-based observations. Folk dance can transmit embodied knowledge through movement and performance. Folk art can communicate symbolic and visual representations of landscapes, species, livelihoods and cultural identity. Festivals and community practices can reinforce collective memory through recurring participation (UNESCO, 2003).

Communities may retain detailed observations concerning species, water, weather, soils, vegetation and seasonal cycles without expressing these observations through scientific terminology. The paper does not equate such knowledge with modern science. Instead, cultural knowledge can serve as a contextual entry point for scientific inquiry and communication. A useful five-stage pathway is: Culture → Recognition → Scientific explanation → Dialogue → Application.

From Local Knowledge to Wider Communication

Knowledge becomes capable of wider circulation when mechanisms exist for documentation, interpretation and communication. The proposed local-to-global pathway is: Local experience → Documentation → Interpretation → Communication → Wider access → Dialogue → Assessment → Adaptation.

This differs from assuming that every local practice is universally transferable. The Rajasthan experiences discussed later in the paper provide examples of how locally situated environmental knowledge and practice can enter wider knowledge networks. Public knowledge platforms such as Sahapedia and PANORAMA provide additional routes through which field experiences can

become accessible beyond their original settings (Mehra, 2016, 2023).

The appropriate concept is knowledge scaling rather than automatic replication. A local intervention may provide transferable principles while requiring substantial adaptation to another ecological, social or institutional context.

Scientific Communication and Scientific Temper in India

Scientific communication includes the processes through which scientific knowledge is interpreted and made available to wider audiences. Scientific temper is broader: it concerns habits of inquiry, evidence-based reasoning, questioning and openness to examination. The two should therefore not be conflated (Constitution of India, 1950; Reincke et al., 2020).

Science popularisation, public lectures, popular articles, vernacular communication, field guides, environmental education, media interaction and citizen-science activities can all contribute to the communication ecosystem. The authors' professional records document extensive scientific and popular communication, including scientific and popular articles, Hindi field guides, presentations, invited lectures, training and public environmental engagement. These outputs demonstrate communication activity but do not by themselves establish measured changes in scientific literacy or scientific temper.

Hindi field guides provide an important example of knowledge translation. Scientific ornithological information can be transformed into accessible identification resources for readers and field observers. Uttar Bharat ke Pakshi and Bharat ke 100 Samanya Pakshi illustrate this form of vernacular knowledge translation (Grimmett et al., 2004; Kasambe & Mehra, 2020).

Environmental education and citizen engagement provide another layer. Documented bird festivals, environmental activities and citizen-science-oriented communication create opportunities for audiences to move from receiving information toward observation and participation (Mehra, 2018; Mehra et al., 2019). The emerging model is therefore: Scientific knowledge → Translation → Public communication → Encounter → Participation → Feedback.

Community Libraries as Knowledge Interfaces

A community library can be understood not merely as a repository of information but as a potential knowledge interface connecting people, knowledge resources, cultural memory, scientific communication and emerging technologies. The conventional repository model emphasises collection and preservation. The interface model adds access, curation, learning, interaction and feedback.

A community library can potentially preserve scientific and cultural resources; provide access to printed and digital materials; connect local users with external knowledge networks; support environmental and scientific literacy;

host lectures, exhibitions and learning activities; facilitate citizen-science participation; preserve local oral and documentary histories; and provide guidance for digital and AI-mediated information discovery (IFLA Artificial Intelligence SIG, 2024; International Federation of Library Associations and Institutions, 2025).

A Community Knowledge Interface Model can therefore be represented as: PRESERVE → CURATE → CONNECT → TRANSLATE → ENABLE → ENGAGE → FEEDBACK. The proposed Community Knowledge Interface Model is illustrated in Figure 2.

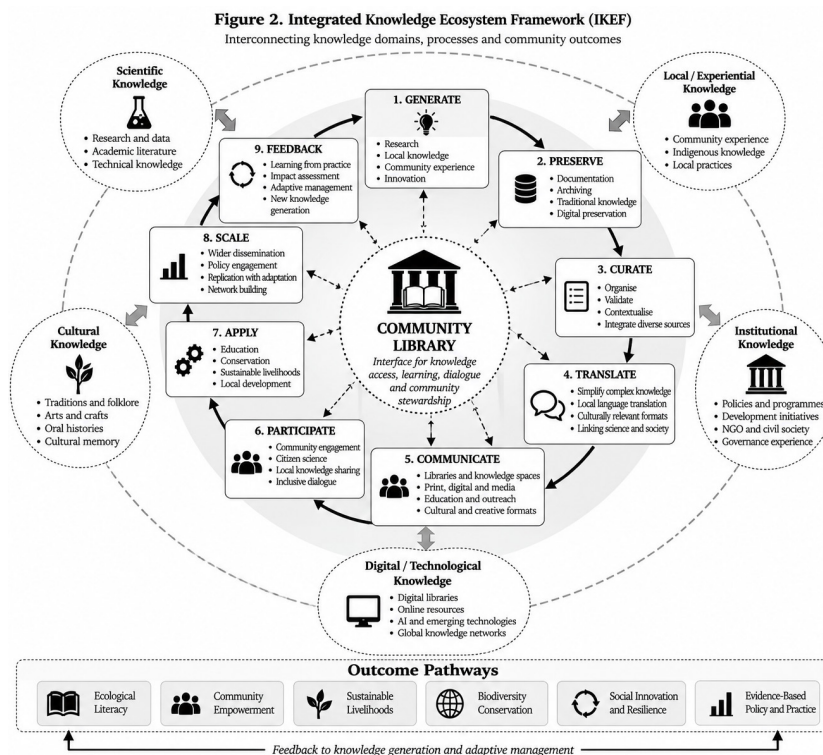


Figure 2: Community Library as a Knowledge Interface

Documented Indian and Rajasthan Experiences Abu Hills / Abu Model

The Abu Hills experience centres on the Green Avadavat (*Amandava formosa*), local youth participation, livelihoods and conservation. Documentation describes involvement of local youth in conservation-oriented activities and nature guiding. The experience provides a pathway from species knowledge and local ecological experience toward community participation and conservation communication (Mehra, 2023).

Bharatpur / Chak Ramnagar / Project Boond

The Chak Ramnagar/Project Boond experience addresses water security, ecological restoration, community participation and livelihood dimensions. It combines local knowledge, including Banjara knowledge, with water-harvesting and recharge practices, ponds and wells, village participation and greening. The use of *Saccharum munja* for value-added products provides an additional livelihood dimension (Mehra, 2012).

Dholpur / Chambal

The Dholpur study provides documentation concerning wetlands and environmental conditions in the district, illustrating the importance of site-specific ecological and social knowledge in landscape assessment (Mehra &

Mehra, 2013).

Kumbhalgarh

The Kumbhalgarh Model is identified in the authors' professional record as a local-governance and community-oriented initiative involving revival and value addition of traditional wooden articles. It is included here as documented professional/project experience rather than as an independently evaluated research case. The available record does not provide an independent evaluation of outcomes; accordingly, no measured conservation, livelihood or public-understanding effects are inferred.

Keoladeo / Bharatpur

The Keoladeo experience combines biodiversity, water and landscape concerns with documentation and public knowledge resources. The documented work provides an example of movement from field observation and environmental assessment toward wider communication and learning (Mehra & Mehra, 2014; Mehra, 2016).

Public Knowledge Platforms

Public-facing documentation through platforms such as Sahapedia and PANORAMA provides mechanisms through which locally situated environmental experiences can become accessible to wider audiences (Mehra, 2016, 2023).

Hindi Field Guides

Uttar Bharat ke Pakshi and Bharat ke 100 Samanya Pakshi illustrate the transformation of ornithological knowledge into Hindi-language field identification resources (Grimmett et al., 2004; Kasambe & Mehra, 2020).

Environmental Education and Citizen Engagement

Documented environmental festivals, public education and citizen-science-oriented activities create communication pathways linking information with public encounter and participation (Mehra, 2018; Mehra et al., 2019). The broader community-development literature also emphasises multidimensional approaches linking education, empowerment, livelihoods and sustainable development, reinforcing the importance of treating participation as part of a wider community-development process rather than as an isolated communication activity (Chinthakindi & Katherasala, 2025). Across these cases, the common pathway is: Landscape → Experience → Knowledge → Documentation → Translation → Institutional mediation → Public engagement → Wider knowledge exchange.

Digital and Emerging Science-Communication Tools

Contemporary knowledge ecosystems are supported by a diverse communication toolkit. Digital repositories strengthen preservation and access; digital storytelling combines text, photography, audio, video and maps; GIS and visualisation communicate spatial relationships; and multimedia platforms create reusable communication resources. Open science provides a broader framework for access and participation (UNESCO, 2021).

Citizen science creates a feedback relationship between experts and publics. Members of the public may

contribute species observations, photographs or environmental measurements, but contributions require appropriate protocols for identification, metadata and validation (Aceves-Bueno et al., 2015; Balázs et al., 2021). AI introduces potential applications in discovery, translation, summarisation, accessibility and metadata support. At the same time, AI-generated information requires attention to provenance, accuracy, context and verification (IFLA Artificial Intelligence SIG, 2024; International Federation of Library Associations and Institutions, 2025). Digital preservation remains equally important because digitally created information may become difficult to access through obsolete formats, platform dependence, broken links or metadata loss.

Integrated Knowledge Ecosystem Framework

The Integrated Knowledge Ecosystem Framework (IKEF) connects the historical, cultural, scientific, institutional and technological dimensions developed in the preceding sections. Its central proposition is that public understanding of science may be supported when knowledge generation, preservation, translation, communication, access and participation are connected through social, cultural, institutional and technological interfaces.

The core architecture is: Generate → Preserve → Curate → Translate → Communicate → Participate → Apply → Scale → Feedback → Generate. Nine interconnected ecosystem functions are therefore identified. Five interacting knowledge domains are distinguished: Scientific knowledge; Local and experiential knowledge; Cultural knowledge; Institutional knowledge; Digital and technological knowledge environments.

The framework emphasises interfaces: Scientist ↔ Community; Scientist ↔ Communicator; Library ↔

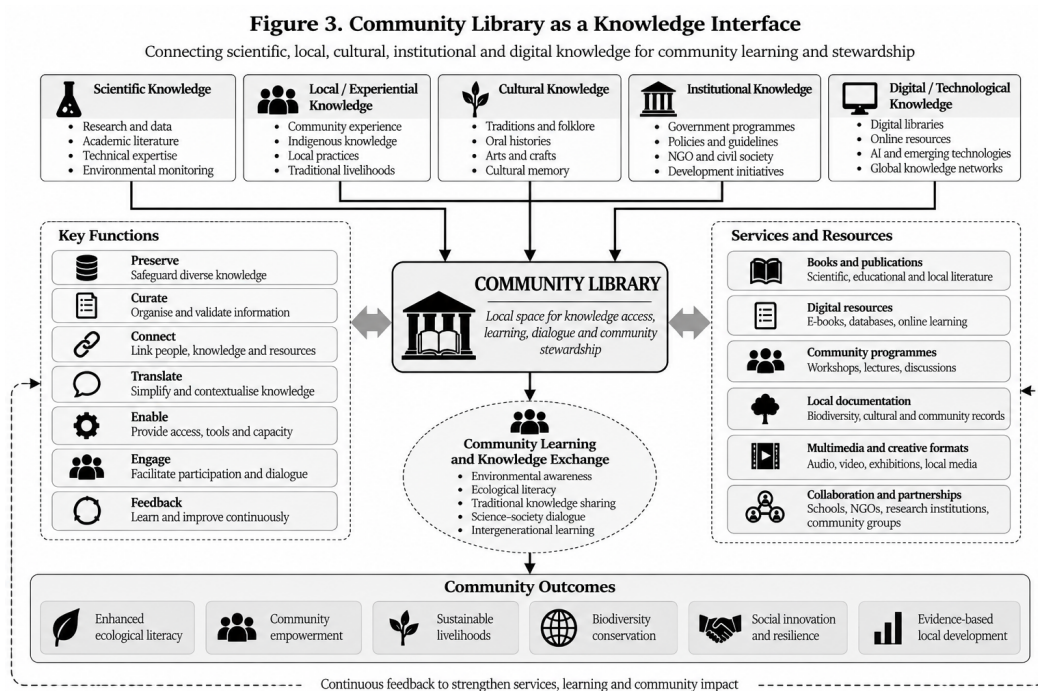


Figure 3: Integrated Knowledge Ecosystem Framework (IKEF)

Public; Community ↔ Library; Traditional knowledge ↔ Scientific research; Digital platform ↔ Public; AI ↔ Knowledge repository. The community library occupies a potentially important position because it can connect scientific knowledge, cultural knowledge, local experience, educational resources and digital networks.

The framework also incorporates an evidence and validation layer. Different claims require different forms of assessment, and knowledge circulation must not be confused with knowledge validation. Under the curation function, relevant tasks include organisation and contextualisation rather than automatic validation.

The resulting Integrated Knowledge Ecosystem Framework is presented in Figure 3.

Discussion and Implications

The Integrated Knowledge Ecosystem Framework provides a way of connecting historical systems of knowledge transmission with contemporary scientific communication, community libraries, digital technologies and participatory approaches.

The first implication is that knowledge-transfer systems should be understood as layered rather than simply sequential. Oral traditions, printed books, libraries, scientific journals, digital repositories and AI interfaces can coexist.

Second, access is necessary but not sufficient. The pathway should be distinguished as: Access → Understanding → Participation → Application. A digital repository can improve availability without ensuring comprehension. A science communicator and community library can provide complementary forms of mediation.

Third, science communication is a translation process involving selection, interpretation, contextualisation, language and presentation. Documented scientific and

popular communication provides examples of this process, while not constituting proof of measured changes in scientific literacy.

Fourth, local and scientific knowledge should be distinguished without being isolated. They can enter dialogue through documentation, investigation and appropriate application.

Fifth, scaling should be distinguished from replication. A local experience may yield principles useful elsewhere without implying that the entire intervention can be transferred unchanged.

Sixth, participation changes the communication relationship from Expert → Public toward Expert ↔ Community ↔ Institution ↔ Public. Citizen science is a clear example, but participation requires appropriate validation.

Seventh, technology creates both opportunities and vulnerabilities. Digital systems can expand access, visualisation, participation and preservation while also producing information overload, misinformation, unequal access and source confusion.

Eighth, AI changes the role of knowledge professionals. Librarians and information professionals may increasingly act as curators, navigators, verifiers and educators in addition to custodians of collections.

Ninth, preservation and openness require balance. Community and Indigenous knowledge may require consent, attribution, cultural ownership and contextual safeguards (UNESCO, 2015).

The framework has several limitations. It is conceptual rather than a controlled empirical evaluation; communication outputs do not automatically demonstrate changes in knowledge or behaviour; the Rajasthan cases are context-dependent; participation does not equal scientific validation; digital access is unequal; and

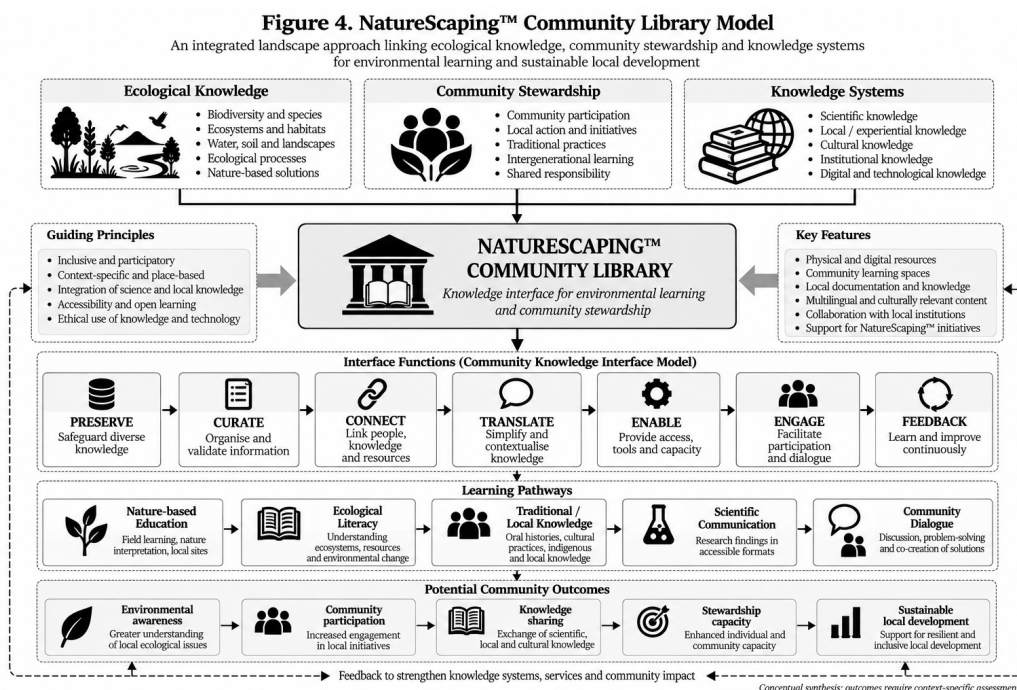


Figure 4: NatureScaping™ Community Library Model

AI introduces continuing governance questions. The framework consequently provides a research agenda rather than a completed causal model.

NatureScaping™ Community Library Model

The synthesis is represented in the NatureScaping™ Community Library Model (Figure 4). The model connects ecological knowledge, community stewardship and scientific, local, cultural, institutional and digital knowledge systems through a community-oriented knowledge interface. Its guiding principles include inclusive participation, place-based learning, integration of scientific and local knowledge, accessible/open learning and ethical use of knowledge and technology.

The model proposes physical and digital resources, community learning spaces, local documentation, multilingual and culturally relevant content, collaboration with local institutions and support for NatureScaping™ initiatives. Its interface functions are Preserve, Curate, Connect, Translate, Enable, Engage and Feedback. Learning pathways include nature-based education, ecological literacy, traditional/local knowledge, scientific communication and community dialogue. The model identifies potential outcomes including environmental awareness, community participation, knowledge sharing, stewardship capacity and sustainable local development. These are proposed pathways and potential outcomes, not empirically demonstrated effects.

CONCLUSION

This paper examined scientific communication and public understanding through the broader concept of a knowledge ecosystem. Rather than treating communication as a one-way transfer from experts to the public, the study conceptualised knowledge as moving through interconnected processes of generation, preservation, curation, translation, communication, participation, application, scaling and feedback.

The documentary synthesis indicates that knowledge-transfer systems have changed considerably in medium and institutional form, from oral and cultural mechanisms through manuscripts, libraries, print and broadcast systems to digital networks and AI-enabled environments. These developments should not be understood simply as successive replacements. Contemporary knowledge ecosystems can contain several layers simultaneously, with older cultural and community-based mechanisms interacting with modern institutional and digital infrastructures.

The study also identifies the importance of interfaces. Scientists, science communicators, librarians, communities, cultural knowledge holders, institutions and digital platforms can connect otherwise separated knowledge environments. Within this system, community libraries have potential to function beyond conventional repository roles by supporting preservation, curation, connection, translation, learning, engagement and feedback.

The documented Rajasthan experiences illustrate several pathways through which environmental and community knowledge can move from local experience toward documentation, communication and wider knowledge exchange. These examples include biodiversity conservation, water-related initiatives, environmental education, citizen engagement, public knowledge platforms and Hindi-language field communication. They are treated as contextual examples rather than as controlled evaluations or universal models.

The proposed Integrated Knowledge Ecosystem Framework (IKEF) provides a conceptual structure for connecting these functions. Its principal contribution is to distinguish knowledge circulation from validation, information access from understanding, participation from scientific validation and scaling from automatic replication. These distinctions are important when scientific, local, cultural, institutional and digital knowledge environments interact.

The NatureScaping™ Community Library Model extends this synthesis toward an applied environmental-learning context by connecting ecological knowledge, community stewardship and multiple knowledge systems through a community-oriented knowledge interface. The model remains conceptual and should be tested through future empirical research rather than being interpreted as an already validated intervention.

The future of scientific communication may therefore depend not simply on choosing between traditional and digital systems, but on connecting their complementary strengths while maintaining evidence, context, accessibility, ethical stewardship and meaningful opportunities for participation. The knowledge ecosystem perspective provides a framework for further empirical research into how such interfaces can contribute to public understanding, community learning, environmental stewardship and socially relevant knowledge exchange.

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