concerns about non-target effects and ecotoxicity require thorough evaluation before large-scale implementation. Integrating nanotechnology with biological controls and environmentally friendly compounds could form a multifaceted approach that addresses current challenges like resistance development and operational constraints in malaria vector management (Benelli, 2015; Benelli et al., 2018).

6 Development and Implementation of Integrated Vector Management (IVM)

6.1 Theoretical framework and core principles of IVM

Integrated Vector Management (IVM) is a rational decision-making process designed to optimize the use of resources for vector control by combining multiple strategies tailored to local contexts. Its core principles emphasize evidence-based decision-making, integration of various control methods, intersectoral collaboration, advocacy, social mobilization, legislation, and capacity building. This approach recognizes that effective vector control is not solely the responsibility of the health sector but requires coordinated efforts across multiple sectors and stakeholders to address the complex determinants of vector-borne diseases (Beier et al., 2008; Onoh et al., 2020). IVM aims to enhance efficacy, cost-effectiveness, ecological soundness, and sustainability by promoting interdisciplinary integration and adapting interventions to changing environmental and epidemiological conditions (Onoh et al., 2020; Tourapi and Tsioutis, 2022).

The theoretical framework of IVM also incorporates adaptability to emerging challenges such as climate change, urbanization, and evolving vector behaviors. It advocates for locally adapted strategies that consider environmental impacts from human activities and demographic shifts influencing disease transmission dynamics. The Circular Policy concept highlights the need for continuous planning, implementation, enforcement, and validation cycles within IVM programs to maintain effectiveness amid these dynamic factors. This holistic approach ensures that vector control remains responsive to new scientific knowledge and technological advancements while aligning with planetary health goals (Figure 4) (Tourapi and Tsioutis, 2022; Tiffin et al., 2025).

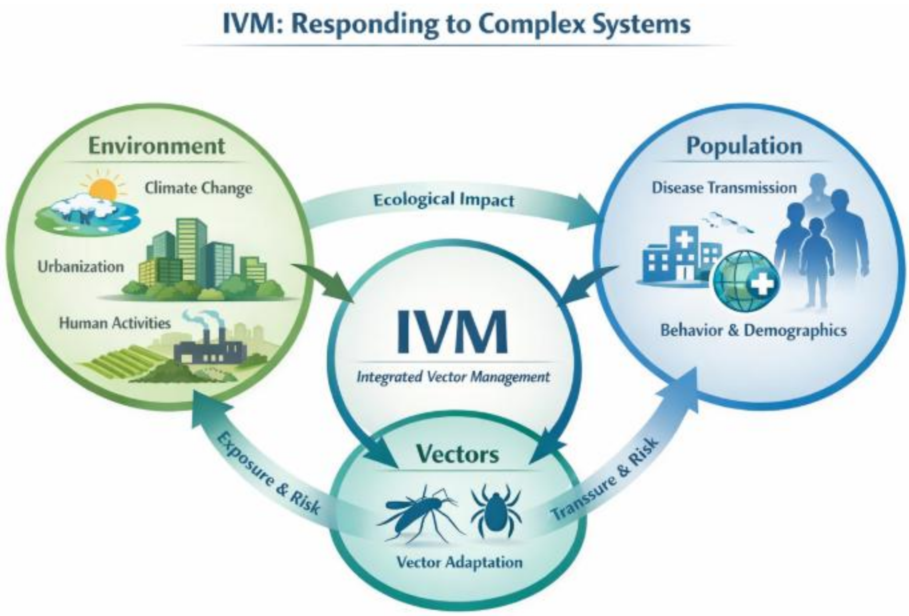

Figure 4 Interactions among environment, vectors, and human populations within the Integrated Vector Management (IVM) framework under dynamic socio-environmental changes (Adopted from Tourapi and Tsioutis, 2022)

6.2 Multi-strategy integration models

Multi-strategy integration within IVM involves combining chemical, biological, environmental, and genetic control methods in a complementary manner to maximize impact on vector populations. For example, integrating insecticide-treated nets with larval source management and biological agents like Wolbachia-infected mosquitoes can address different mosquito life stages and behaviors simultaneously. Such combinations help mitigate