**Table 1. Comparative overview of existing sustainability and livability frameworks versus the Sustainable Livability Index (SLI)**

| **Framework / Index** | **Core Dimensions** | **Strengths** | **Limitations** | **Added value of SLI** |
| --- | --- | --- | --- | --- |
| **Human Development Index (HDI)** | Health, education, income | Widely recognized, simple, policy relevance | Ignores ecological feedbacks; no psychosocial dimension | Integrates ecological and psychosocial indicators alongside social–economic ones |
| **Ecological Footprint (EF)** | Resource use vs. biocapacity | Clear measure of ecological overshoot | Limited social dimension; does not capture governance or well-being | Combines ecological pressure with human well-being and governance |
| **Environmental Performance Index (EPI)** | Air, water, biodiversity, climate | Quantitative, comparable across nations | Focuses only on environment; excludes human/social feedbacks | Embeds environmental metrics into coupled human–environment system |
| **Well-being Index (OECD, UN frameworks)** | Subjective life satisfaction, health, safety | Captures psychosocial well-being | Weak ecological integration; often subjective | Links psychosocial well-being to ecological and governance conditions |
| **Sustainable Livability Index (SLI)** | Ecological, human, governance, psychosocial | Holistic, multi-scalar, predictive, policy-oriented | Requires multi-source data; novel approach needing validation | Provides integrative and dynamic measure capturing coupled human–environment–psychosocial systems |

**Table 2. Dimensions and indicators of the Sustainable Livability Index (SLI)**

| **Dimension** | **Indicators (examples)** | **Description** | **Data sources** |
| --- | --- | --- | --- |
| **Ecological** | Water availability, air quality, biodiversity index, land degradation | Captures environmental capacity and ecosystem health | Remote sensing (NASA, ESA), national environmental agencies |
| **Human (Socio-economic)** | Income, education level, employment rate, population density | Represents demographic and socio-economic pressures | National statistics, World Bank, UNDP |
| **Governance / Institutional** | Corruption perception index, policy effectiveness, participation, climate risk index | Reflects institutional quality, adaptive capacity, and governance resilience | World Governance Indicators, UNDP, IPCC |
| **Psychosocial** | Environmental anxiety, social trust, migration intention, perceived well-being | Captures community perceptions, resilience, and mental health | Household surveys, WHO, Gallup World Poll |
| **Composite SLI** | Weighted integration of the above | Dynamic measure of coupled human–environment–psychosocial system | Calculated via ML-SEM / XGBoost |

**Table 3. Case application of the Sustainable Livability Index (SLI) in two ecosystems (illustrative data)**

| **Dimension** | **Indicators (examples)** | **Lake Urmia (2010)** | **Lake Urmia (2020)** | **Hoor-al-Azim (2010)** | **Hoor-al-Azim (2020)** |
| --- | --- | --- | --- | --- | --- |
| **Ecological** | Water level (m), Biodiversity index | 1272 m / 0.62 | 1267 m / 0.35 | 0.70 | 0.40 |
| **Human** | Population density (per km²), Agricultural water use (%) | 95 / 72% | 110 / 85% | 60 / 68% | 75 / 80% |
| **Governance** | Policy effectiveness (0–1), Climate risk index | 0.45 / 0.62 | 0.40 / 0.68 | 0.50 / 0.60 | 0.42 / 0.66 |
| **Psychosocial** | Migration intention (%), Environmental anxiety (0–1) | 22% / 0.45 | 38% / 0.62 | 18% / 0.40 | 31% / 0.55 |
| **Composite SLI** | Calculated (0–1 scale) | 0.58 | 0.39 | 0.62 | 0.46 |

**Table 4. Policy scenarios and interpretation of Sustainable Livability Index (SLI) thresholds**

| **SLI Range** | **System status** | **Characteristics** | **Policy implications** |
| --- | --- | --- | --- |
| **> 0.70 (Stable Zone)** | Sustainable & resilient | Ecosystems function within capacity; human well-being and governance strong | Maintain policies; promote adaptive governance; invest in innovation for resilience |
| **0.50 – 0.70 (Early-warning Zone)** | Vulnerable, under stress | Signs of ecological decline; rising social tension or migration intention | Implement corrective actions (reduce water extraction, diversify livelihoods, strengthen institutions) |
| **0.35 – 0.50 (Critical Transition Zone)** | At risk of collapse | Severe ecological degradation, governance gaps, high psychosocial distress | Urgent interventions (emergency restoration, relocation programs, international cooperation) |
| **< 0.35 (Collapse Zone)** | Breakdown | Irreversible ecological shifts; mass migration; loss of social trust | Crisis management, humanitarian response, long-term ecosystem rehabilitation |