

Land-use Mapping: GIS and Remote Sensing Uses for Svay Rieng Province, Cambodia (2020–2025)

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ABSTRACT

Purpose of the study: This review evaluates how geographic information systems (GIS) and remote sensing can support land-use mapping in Svay Rieng Province, Cambodia, from 2020 to 2025. It considers agricultural management, water and flood-risk assessment, settlement and industrial monitoring, and provincial spatial planning.

Methodology: A narrative review synthesized peer-reviewed studies, Cambodian statistics and policy documents, technical datasets, and reports from intergovernmental and development organizations. Evidence was classified as direct Svay Rieng, Cambodia-wide, Lower Mekong or adjacent-province transfer, or general methodological evidence.

Main Findings: No locally validated, multi-class land-use map for Svay Rieng during 2020–2025 was identified. The province is a lowland, rice-based landscape with seasonal water dynamics and a developing urban-industrial border corridor around Bavet. A suitable mapping system should separate wet-season paddy, other cropland, permanent and seasonal water, flooded vegetation or wetlands, tree cover, rural settlements, transport corridors, and built-up or industrial land. Sentinel-1 radar and Sentinel-2 optical time series offer a practical 10-m foundation. Landsat supports historical continuity, while high-resolution imagery can strengthen reference data in fragmented areas. GIS improves interpretation through topographic, hydrological, irrigation, road, administrative, planning-zone, and exposure layers. Recommended practices are clear class definitions, seasonal compositing, local reference data, spatially independent probability-based validation, and classification-error-adjusted area estimates.

Novelty/Originality of this study: This Svay Rieng-specific review separates direct provincial evidence from Cambodian and Lower Mekong method-transfer evidence, avoiding unsupported local claims. It proposes a repeatable provincial information system, rather than a static map, for plan review, rice and water management, flood-drought analysis, ecosystem screening, and accountable land-conversion monitoring.

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1. INTRODUCTION

Land-use mapping is necessary for provincial planning where agricultural production, water management, settlement growth, climate risk, and infrastructure development share the same landscape. A

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rigorous study must first distinguish land cover from land use. Land cover is the observable biophysical surface, including cropland, trees, water, bare ground, or impervious surface. Land use is the human purpose or management associated with the land, such as rice cultivation, settlement, industry, transport, conservation, or irrigation. Satellites observe cover directly, whereas use, tenure, zoning, and production practice normally require corroboration from field observations, administrative records, planning documents, or community knowledge [1].

This distinction is especially important in Svay Rieng Province. The province had 525,497 residents in 2019, occupied 2,966 km², and had a population density of 177 persons per km² [2]. Its setting is low lying, with reported elevations of approximately 5–18 m, rainy-season field flooding, shallow wetland depressions, streams, and sandy northern soils [3]. These conditions make a single-date image and a generic “agriculture” class inadequate. A map must distinguish wet-season paddy, other cropland, fallow land, temporary inundation, permanent water, wetland vegetation, and settlement fabric if it is to be useful for provincial decisions.

A second land-system pattern is the Bavet border corridor. Bavet lies on National Road 1 near Viet Nam and forms part of the Southern Economic Corridor. It contains special economic zones (SEZs), casinos, logistics activity, and associated urban growth [4]. Planning evidence reports ten operating Bavet SEZs by 2019 and a substantial SEZ workforce, although agricultural land remained important outside the development corridor [5]. These conditions create a plausible land-conversion pressure, but planning evidence cannot measure the location, timing, or amount of conversion. Repeated, time-stamped and accuracy-assessed maps are required to determine whether cropland, wetlands, or other cover types have changed to built-up, industrial, transport, or service uses.

Remote sensing and GIS can supply this information when they are used as an integrated system. Remote sensing provides repeated observations of surface conditions. GIS links those observations to terrain, hydrology, irrigation assets, roads, administrative boundaries, planning zones, settlements, and exposure data. The approach can support rice and water management, flood–drought analysis, land-conversion monitoring, ecosystem screening, and spatial-plan review. It also has limits: satellite-derived maps cannot determine land rights, settle cadastral boundaries, or prove legal land use.

The evidence base must be described cautiously. A historic Svay Rieng flood study demonstrates that satellite-based mapping is locally relevant: it estimated 40,592 ha of inundation and 11,170 ha of affected paddy during the October 2013 flood [6]. This is not a 2020–2025 land-use result. Likewise, Bavet planning sources establish development context but not observed land-cover change [5], [7]. The review therefore separates direct provincial evidence from Cambodia-wide, Lower Mekong, and general method-transfer evidence. Its objectives are: 1) to synthesize available data and methods for mapping Svay Rieng land use and cover during 2020–2025; 2) to identify evidence-supported applications for provincial management; and 3) to propose a transparent and validation-focused mapping framework.

2. RESEARCH METHOD

2.1. Review Design and Scope

This article used a narrative-review design. The review covered the 2020–2025 period for contemporary mapping products, policy documents, and applications. Older sources were included only when they established a foundational definition, a standard accuracy-assessment procedure, or the only directly relevant historic Svay Rieng mapping application. The review did not create a new satellite classification or estimate provincial land-use area. Its purpose was to determine what can be responsibly concluded from the available evidence and what workflow is appropriate for a future 2020–2025 provincial map series.

The evidence was grouped into four categories. The first category included direct Svay Rieng evidence, such as demographic, water, flood, and Bavet-corridor documents. The second included Cambodia-wide evidence, such as national land-cover and paddy maps. The third included Lower Mekong or adjacent-province transfer evidence, including studies in the Cambodian Mekong Delta, Prey Veng, and Takeo. The fourth included general methodological evidence on sensors, classification, accuracy assessment, metadata, and data governance. This hierarchy prevents a national map from being interpreted as a validated local map.

2.2. Source Selection and Evidence Extraction

The reviewed material included peer-reviewed articles, government statistical publications, official policy documents, public geospatial datasets, and reports from the Mekong River Commission (MRC), the Food and Agriculture Organization of the United Nations (FAO), the World Bank, the Asian Development Bank, and related public institutions. Sources were selected when they met one or more of the following criteria: 1) they described Svay Rieng’s physical, agricultural, hydrological, urban, or planning context; 2) they provided a Cambodia or Lower Mekong mapping application relevant to paddy, water, wetlands, forest, built-up land, or

land-use change; 3) they documented sensor capabilities, reference products, or GIS datasets usable in the province; or 4) they established accepted principles for validation, area estimation, metadata, or data privacy.

For each source, the following were extracted: geographic scope; reference period; target classes or processes; sensor and ancillary inputs; analytical method; validation method; reported performance; and limitations. Findings were then coded as either a directly evidenced provincial observation or a transferable proposition requiring local testing. National statistics and national map accuracy values were not used as provincial statistics or accuracy values. This rule is central to the review because class definitions, image dates, spatial resolution, landscape fragmentation, reference data, and validation designs vary substantially among products.

2.3. Study Area and GIS Context

The study area is Svay Rieng Province in southeastern Cambodia. The province is a lowland agricultural landscape with a strong rice and seasonal-water context [3]. Its physical conditions motivate a legend that separates water-related classes by timing and function. The historic flood analysis [6] shows that floodwater and affected paddy can be mapped separately, whereas the provincial water-supply documentation highlights the Vaiko/Tonle Vaiko river setting and water-infrastructure context [3].

GIS provides the geographic framework for this interpretation. Administrative units from the Cambodia Common Operational Dataset can support province, district, and commune/sangkat summaries [8]. The MRC irrigation dataset provides reconnaissance layers for irrigation areas, reservoirs, headworks, and projects [9]. These sources are useful for analysis, but they are not cadastral or legally authoritative layers. In particular, the irrigation inventory has a 2017 reference date and incorporates older inputs. It should be updated through current imagery, local records, and field verification before it is used to characterize irrigation conditions during 2020–2025.

2.4. Analytical Framework for Mapping Review

The analytical framework assessed five components: 1) satellite observations; 2) GIS covariates; 3) classification and change-detection methods; 4) accuracy assessment and area estimation; and 5) decision applications. The desired output is not simply an annual thematic image. It is a versioned information system containing a class legend, source dates, processing records, validation data, uncertainty estimates, change matrices, and decision-relevant GIS overlays.

The proposed cover legend has two levels. The broad level contains cropland, tree cover, water, flooded vegetation or wetland, built-up land, bare or sparsely vegetated land, and grass/shrub. The detailed level distinguishes wet-season paddy, dry-season paddy where applicable, non-rice annual crops, perennial or orchard-like vegetation, fallow land, permanent water, seasonal water, event inundation, rural settlement, transport/logistics land, and industrial or SEZ fabric. These detailed classes are hypotheses for provincial implementation, not an assertion that every class can be separated everywhere with the same accuracy. Use attributes, such as tenure, legal zoning, crop management, and irrigation status, should be stored separately with their evidence source and confidence.

3. RESULTS AND DISCUSSION

3.1. Evidence Availability and Existing Mapping Products

The principal finding is an evidence gap. No readily identifiable, locally validated, multi-class land-use map for Svay Rieng published during 2020–2025 was found in the reviewed evidence. Direct provincial sources establish the need for mapping rather than supplying such a product. The 2013 flood-and-rice study provides a direct proof of local satellite-mapping relevance, but it predates the target period [6]. Bavet planning documents identify likely development pressure, but do not quantify its mapped footprint or conversion rate [5], [7]. Consequently, a Svay Rieng 2020–2025 map should be presented as a new, locally validated product rather than as a simple extraction from a national database.

Several regional and national products provide an important starting point. The MRC's 2020 Lower Mekong land-use/land-cover product used Landsat 8, Sentinel-1, Sentinel-2, Planet imagery, field reference data, cloud computing, and machine learning. It reported 87.1% overall accuracy using 2,198 independent validation points [10]. The product is a valuable regional baseline and methodological reference; however, its reported accuracy is not a class-specific or province-specific Svay Rieng estimate. ESA WorldCover supplies a 10-m global 2020 Sentinel-1/2 product with a reported globally independent overall accuracy of 74.4% [11]. It is useful as a comparator or sample-screening layer, but its global accuracy cannot be assigned to local classes.

A Cambodia-wide 10-m 2020 land-cover study reported 91.68% overall accuracy and a Kappa coefficient of 0.8808 [12]. Its class set included water, forest, impervious surface, cropland, grass/shrub, flooded vegetation, and bare land. This makes it especially useful as a candidate baseline and taxonomy reference.

Nonetheless, it used national-scale training and validation design. The broad cropland class and national validation frame do not establish how accurately the product distinguishes paddy, wetland, settlement, or industrial land in Svay Rieng.

A second Cambodia-wide study demonstrates the value of phenology-aware paddy extraction. Kang et al. combined Sentinel-1, Sentinel-2, prior land-cover information, rice phenology, and topography in Google Earth Engine, reporting 89.90% overall accuracy for paddy mapping [13]. In the Cambodian Mekong Delta, Orieschnig et al. compared classifiers using multi-temporal Sentinel-1/2 data. Gradient Tree Boosting (GTB) and Random Forest (RF) yielded the highest reported overall accuracies, 94% and 93%, respectively, and radar–optical fusion raised performance by 10–15 percentage points for several models [14]. These findings are strong transfer evidence for testing seasonal SAR–optical fusion, but they are not evidence of a specific Svay Rieng paddy area or expected accuracy.

3.2. Satellite and GIS Data for Provincial Mapping

Sentinel-2 is the most practical free optical foundation for detailed 2020–2025 mapping. It provides 13 spectral bands at up to 10-m resolution, a 290-km swath, and an approximately five-day revisit period with the Sentinel-2 constellation [15]. Its visible, near-infrared, red-edge, and shortwave-infrared bands can discriminate vegetation condition, water, soil moisture, bare surfaces, and built materials. Its principal limitation is monsoon cloud and haze. These gaps can occur precisely when paddy, seasonal water, and flooded vegetation must be differentiated.

Sentinel-1 provides cloud-independent C-band radar observations and is therefore the essential complement. Google Earth Engine documentation indicates that Sentinel-1 Ground Range Detected products are processed for orbit information, border and thermal noise, radiometric calibration, and terrain correction [16]. Analysts must still control acquisition mode, orbit direction, polarization, and resolution. Time-series VV and VH backscatter can help characterize standing water, rice development, soil moisture, roughness, and built structures. Radar measurements are not direct class labels, however; they remain sensitive to vegetation, incidence geometry, speckle, surface roughness, and mixed pixels. The strongest design is therefore multi-temporal SAR–optical fusion instead of optical-only or radar-only classification.

Landsat 8 and 9 strengthen continuity. Landsat 8 provides 30-m multispectral and 15-m panchromatic imagery, while Landsat 9 provides comparable observations with enhanced radiometric resolution; the two systems have 16-day cycles offset by eight days [17], [18]. Landsat is useful for longer-term context, thermal analysis, and links to historical water products. Its 30-m pixels, however, can mix narrow fields, ponds, roads, and development edges. MODIS data should be used at a different scale. The MCD12Q1 product has 500-m annual land-cover information [19], which is useful for broad phenology or vegetation-condition context but unsuitable for smallholder field delineation.

Targeted very-high-resolution imagery or unmanned-aerial-vehicle observations can improve the interpretation of ambiguous classes, including field edges, ponds, bunds, settlement–crop interfaces, and compact industrial parcels. In adjacent Prey Veng and Takeo, land-use mapping used 0.5-m Pléiades and 1.5-m SPOT 7 imagery, object-based analysis, SVM, field data, and Google Earth or RIICE validation. The study also reported spectral and seasonal difficulties in distinguishing some agricultural classes [20]. Such imagery is most efficient when concentrated in fragmented or uncertain strata rather than used as an assumed complete substitute for wall-to-wall satellite coverage.

A GIS stack should integrate terrain, hydrography, drainage, roads, settlement footprints, public facilities, crop calendars, soil or agroecological zones, administrative areas, and dated planning layers. SRTM offers a near-global digital elevation model at approximately 30-m resolution [21]. Elevation, slope, and position relative to drainage can improve classification because they represent environmental constraints. They must remain predictors, not circular proof. A low-elevation pixel may have a higher likelihood of seasonal water, but elevation alone does not prove that the pixel was inundated during a given period.

3.3. Classification and Change-Detection Findings

The reviewed evidence favors a seasonal feature stack over a single annual composite. A single median image may obscure crop stages and replace temporary water with a misleading annual average. For each map year, a practical scheme should include pre-monsoon, early wet-season, peak wet-season, harvest or recession, and dry-season windows. Sentinel-2 features can include reflectance bands, vegetation indices, water indices, moisture indices, and red-edge measures. Sentinel-1 features can include VV and VH summaries, ratios, temporal amplitude, percentiles, and timing-of-peak metrics. Terrain and distance-to-water layers can be added as ancillary covariates.

RF, GTB, and SVM are appropriate starting classifiers because they can model nonlinear relationships with mixed predictor sets and modest training samples. Their ranking should be empirically tested rather than assumed. In Cambodian plantation and successional-forest mapping, SVM performed better than RF under particular sensor combinations, demonstrating that feature selection, class definition, and tuning can outweigh

the general reputation of an algorithm [22]. A transparent provincial workflow should compare a limited set of models using the same training, tuning, and independent assessment samples.

Object-based image analysis can be useful where a pixel-based map fragments coherent fields, ponds, industrial compounds, or settlement blocks. It groups adjacent pixels into meaningful objects and adds shape, texture, and neighbourhood information. The nearby Prey Veng and Takeo evidence supports testing an object-based or hybrid design in complex strata, particularly fragmented agriculture and the Bavet built-up edge [20]. It does not prove that an object-based method will outperform pixel classification across the entire province.

Deep-learning segmentation is a more demanding alternative. A high-resolution benchmark reported higher test performance for U-Net and Swin-UNet than for earlier convolutional architectures [23]. The result is not transferable as a projected Svay Rieng accuracy because it depends on its imagery, classes, labelled data, and sample split. Deep models require extensive, representative and independently evaluated labels. They can also yield misleadingly high scores when adjacent image tiles occur in both training and test sets. For a transparent provincial monitoring system, RF or boosting methods may be preferable unless high-quality high-resolution labels are available.

Land-use change should be estimated from harmonized annual maps and confirmed transitions. Post-classification comparison can identify transitions such as cropland-to-built-up, wetland-to-bare land, or water-to-cropland. Its main weakness is that errors from two maps compound in the transition result. National research illustrates the relevance of land-cover and cropland change analysis in Cambodia [24], [25], but those national results must not be used to infer provincial conversion totals. A local procedure should create annual maps using the same legend, independently validate the maps, flag candidate transitions, and review important changes with date-matched high-resolution imagery, local records, and field checks.

3.4. Accuracy Assessment, Area Estimation, and Data Governance

Accuracy assessment is the dividing line between a plausible map and defensible land information. Overall accuracy alone is insufficient. A common class, such as cropland, can dominate the assessment sample and conceal poor performance for policy-critical but less extensive classes, such as seasonal wetland, industrial land, or dry-season paddy. Each map should report a weighted error matrix, overall accuracy, user's accuracy, producer's accuracy, and confidence intervals. User's accuracy indicates the probability that a mapped class is correct. Producer's accuracy indicates the probability that a reference class was mapped correctly. Both are needed because their errors have different implications for planning.

Olofsson et al. recommend probability sampling, temporally appropriate reference labels, area-proportion error matrices, sample-based area estimation, confidence intervals, and explicit treatment of reference-label uncertainty [26]. Stehman provides estimators and standard errors for class areas and accuracy under stratified random sampling [27]. Thus, a reported provincial hectare total should be a reference-sample-adjusted estimate with an uncertainty interval, rather than the raw count of labelled pixels multiplied by pixel area.

Spatial independence is equally important. A random split of neighbouring pixels, points from the same field, or nearby image tiles can cause spatial leakage. Karasiak et al. demonstrate that conventional non-spatial validation can overestimate accuracy when spatial dependence exists [28]. A credible Svay Rieng implementation should separate data into training, tuning, and final assessment components. The final assessment sample should be selected by probability sampling and held out from every modelling choice. It should also be spatially separated by fields, blocks, communes, or another suitable geographic unit.

Reference data should retain geometry, observation date, cover or crop label, crop stage, water condition where known, label source, and interpreter confidence. High-resolution imagery can supplement field data when it is close in date and interpreted under a documented protocol. Administrative rice statistics are useful as aggregate plausibility checks; they are not pixel-level truth. The historic Svay Rieng study found only moderate agreement between MODIS rice estimates and commune statistics, reinforcing this limitation [6].

Farm-level reference data also create a privacy obligation. Detailed field polygons and household-linked labels can reveal livelihoods, assets, production practices, and land claims. Recommended safeguards include transparency, consent, collection and retention limits, secure access, and accountable data sharing [29]. Public products should use aggregated outputs and robust metadata. The OGC Earth-observation metadata standard provides a basis for recording dataset and granule metadata in interoperable GeoJSON or JSON-LD forms [30].

3.5. Applications for Provincial Decision-Making

The first application is seasonal agricultural and water management. A rice map should represent crop timing and water status rather than identify all green vegetation as rice. Seasonal paddy, other crops, fallow land, water occurrence, and irrigation proximity can support extension, crop-calendar interpretation, input targeting, and agricultural-statistics review. The 2023 Census of Agriculture covers all Cambodian provinces, and the Cambodia Agriculture Survey includes some province-level items [31], [32]. These resources can provide

socioeconomic and practice context, but national values must not be restated as Svay Rieng values without province-level tabulations and attention to sampling limitations.

The second application is water and flood management. A Cambodia-wide cloud-based surface-water model generated monthly and annual products from 1988–2018, with annual validation tests above 85% overall accuracy [33]. It also documented cloud obstruction and missing imagery, which can reduce the detection of short-lived inundation. In Svay Rieng, a water-information system should combine optical water indices, Sentinel-1 event observations, terrain and drainage, local reports, and field verification. Permanent water, seasonal water, aquaculture ponds, flooded vegetation, and event inundation should remain separate classes because they imply different management actions.

The third application is flood–drought risk analysis. MRC guidance identifies land use, development, and building controls as tools for reducing flood risk [34]. Cambodia’s climate-risk profile documents high river-flood exposure, a history of repeated major floods and droughts, and future changes in extreme precipitation [35]. A provincial GIS can overlay inundation frequency, drainage, roads, schools, health facilities, settlements, cropland, and wetland areas to identify exposure. This is not a substitute for a hydraulic hazard or damage model. It is an evidence layer that can prioritize field assessment, preparedness, and investment.

The fourth application is climate adaptation and planning. Future floodplain modelling identifies major changes in flood duration and depth for Svay Rieng under future scenarios [36]. These results are prospective scenario outputs, not observations for 2020–2025. Their practical implication is that map systems should keep flood extent, depth, duration, and timing separate. Cambodia also faces documented gaps in flood-hazard, risk, damage, and future-flood mapping [37]. A maintained provincial map series can contribute to filling these gaps when its uncertainty and intended use are clearly stated.

The fifth application is spatial planning, climate reporting, and ecosystem screening. Cambodia’s Land Policy calls for a unified GIS, state-property inventory, spatial planning, and subnational land-use planning [38]. The Updated Nationally Determined Contribution identifies forestry and other land use as an important mitigation component, while NDC 3.0 includes climate-resilient crops and aquatic-habitat actions [39], [40]. Land-cover change maps can provide spatial activity data and help target interventions. They cannot, on their own, estimate carbon stocks, emissions, legal tenure, habitat condition, or social benefit. The Cambodian Sustainable Development Goals framework and biodiversity strategy similarly provide a policy basis for using maps as indicators and screening tools, not as substitutes for official measures or ecological field surveys [41], [42].

3.6. Applications for Provincial Decision-Making

The absence of a verified locally validated multi-class map for 2020–2025 is the review’s most important finding. It should not be interpreted as an absence of usable data. Svay Rieng has access to frequent Sentinel observations, Landsat continuity, national and regional map products, administrative boundaries, hydrological and irrigation context, and transferable Cambodia-specific methods. The gap is instead one of local calibration, validation, interpretation, and maintenance. This distinction changes the recommended response. The province should not simply download a global or national product and treat it as final. It should develop an evidence-managed mapping workflow that uses these products as inputs or comparators and adds local reference evidence.

The direct evidence also identifies why this local work is necessary. Seasonal water and rice dynamics can cause spectral confusion between paddy, wetlands, open water, bare wet soil, and fallow land. Bavet’s development corridor creates a different type of ambiguity, in which industrial parcels, logistics surfaces, housing, roads, vacant land, ponds, and agricultural fragments occur in close proximity. A single legend, model, and accuracy value may conceal these distinct error environments. Stratified sampling and targeted high-resolution reference coverage are therefore more useful than a uniformly distributed convenience sample.

A practical operational design has seven stages. First, a provincial working group should define a hierarchical legend, class crosswalk, minimum mapping unit, and intended planning decisions. The class legend should distinguish observable cover from use attributes and must specify how seasonal water, floodwater, and rice stages will be interpreted. Second, the technical team should build year-specific Sentinel-1 and Sentinel-2 seasonal composites and retain acquisition dates, cloud masks, orbit and polarization settings, and resampling rules. Landsat should be added for continuity, thermal context, and historical comparison.

Third, the team should compile versioned GIS layers for administrative boundaries, terrain, hydrography, roads, settlements, irrigation, public facilities, and planning areas. Each layer should include reference date, source, resolution, license, and usage limitation. Fourth, existing Cambodia and MRC products should be used only for stratification, comparison, and carefully screened weak labels. They should not be used as both the training source and independent validation source for the same result.

Fifth, reference data should be gathered across Bavet/NR1, rice plains, wetlands and water zones, settlements, and ambiguous transition areas. Where field access is constrained, date-matched high-resolution imagery can be interpreted by trained analysts under a documented protocol. Sixth, RF, GTB, and SVM should

be benchmarked with identical samples and a spatially independent holdout. Object-based methods should be added where they demonstrate a measurable benefit. Seventh, final results should include error-adjusted areas, uncertainty intervals, change matrices, data cards, map services, and a plan for annual or periodic update.

Table 1. Stages, Expected Outputs, and Required Safeguards for Geospatial Land-Cover Classification

Stage	Output	Required safeguard
Define ontology	Hierarchical cover legend and evidence-linked use attributes	Do not conflate observed cover, tenure, zoning, and management
Prepare observations	Seasonal Sentinel-1/2 and Landsat composites	Preserve dates, masks, polarization, orbit, and resampling rules
Compile GIS	Terrain, water, roads, irrigation, boundaries, and planning layers	Record source date, scale, license, and legal limitation
Build reference evidence	Field and high-resolution-image labels	Record date, provenance, confidence, and spatial support
Classify	Annual cover maps and candidate transitions	Compare models with the same independent evaluation design
Validate and estimate area	Error matrix, class accuracies, adjusted areas, and intervals	Use probability sampling and spatially independent assessment units
Govern and update	Versioned release, metadata, restricted sensitive data	Assign a custodian, update cycle, and decision-use protocol

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Table 2. Operational Stages, Outputs, and Required Safeguards for Land-Cover Mapping

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The value of the proposed system is strongest when it is connected to a decision cycle. For agriculture, it can distinguish persistent paddy zones, potential cropping intensity, and seasonal water constraints. For water management, it can show where water occurs recurrently and where event inundation intersects with crops, settlements, and transport. For Bavet and National Road 1, it can measure candidate land-cover transitions that

warrant review against plans, permits, infrastructure capacity, and local consultation. For ecosystem and climate activities, it can identify areas for screening and monitoring, while retaining the distinction between a map proxy and a verified ecological or carbon result.

Institutional design is as important as algorithm selection. World Bank reporting identifies fragmented Cambodian hazard and risk mapping and gaps in updating [43]. A provincial map without an owner, schedule, metadata, budget pathway, or policy use will quickly lose value. The recommended custodian should agree on data access, reference-data protection, update frequency, QA procedures, and publication rules. Provincial authorities should also include commune representatives, agricultural and water agencies, and communities in interpretation. Local participation can improve class definitions, explain seasonal practices, reveal issues not visible from imagery, and reduce the risk that a technically accurate output is administratively unusable.

This review is limited by the availability and accessibility of published sources. It did not undertake a systematic meta-analysis, acquire raw imagery, conduct a field survey, or estimate any new Svay Rieng class area. Some reviewed studies used imagery or events before 2020 even though they were relevant methodologically. Their evidence is therefore used for method selection or historical context, not to describe 2020–2025 provincial change.

The proposed mapping approach also has technical limits. Optical imagery can be obscured by cloud, SAR signatures can be ambiguous, 10-m pixels can mix smallholder land covers, and land-use categories may require information beyond satellite observation. Accuracy can vary by season, class, and location. Change estimates compound the uncertainty of annual maps. These limitations do not invalidate mapping; they specify why the map must publish class-specific accuracy, uncertainty intervals, metadata, and intended-use boundaries.

4. CONCLUSION

This review finds that GIS and remote sensing can provide a strong technical basis for land-use mapping in Svay Rieng Province, but that no readily identifiable locally validated, multi-class 2020–2025 map was found in the reviewed evidence. Direct provincial evidence establishes a lowland rice-and-water landscape, historical flood relevance, and a Bavet border corridor where urban-industrial development may create land-conversion pressure. Cambodia-wide and Lower Mekong research provides transferable support for seasonal Sentinel-1 and Sentinel-2 fusion, Landsat continuity, targeted high-resolution reference imagery, GIS integration, machine-learning classification, and rigorous accuracy assessment. The central recommendation is to treat mapping as a maintained provincial information system rather than a one-time map. A credible implementation should separate land cover from land use and tenure; use a seasonal, hierarchical legend; validate with spatially independent probability samples; report weighted accuracy measures and error-adjusted areas; protect sensitive farm-level data; and publish versioned metadata. When embedded in provincial governance, this approach can strengthen rice and water management, flood–drought analysis, land-conversion monitoring, ecosystem screening, and spatial-plan review

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