

The Management of Isolated Environments: Developing a Field-Based Data Collection System for Forest Management in New South Wales

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SUMMARY

The Forestry Corporation of NSW has been managing environmental sustainability, tourism and renewable timber production in NSW's State-owned commercial native and plantation State forests for more than a century. Environmental conservation and community recreation are balanced with timber production and access for other primary industries such as grazing and beekeeping to ensure that the forests sustainably deliver multiple benefits to the community for the long term. The development of a field-based data collection system has allowed management of forest related assets in remote areas where a direct connection to the organisation's data storage network is not possible. With about two million hectares of plantation and native forest under management, the Forestry Corporation required a robust solution that was suitable for data collection and attribute management in isolated areas with minimal or non-existent mobile phone network coverage. Additional requirements included the ability to work offline using a portable device suitable to be carried safely in the field, whilst also being flexible in use independent of location. Feedback from potential users required the development of individual task-based modules to undertake regular functions in the fields of pest management, fire prevention and containment, management of flora and fauna, and site-based planning for harvesting and re-establishment operations. Several options were investigated for platform and operating system stability, with future development maintenance and integration into existing networks and databases also assessed for compatibility. Data transfer mechanisms investigated included those with direct and indirect network connections, with the ongoing maintenance of temporary storage platforms also considered. The development of the FcMapApp has enabled the Forestry Corporation to integrate field-based data collection activities with existing forest management operations whilst also providing a sound basis for tactical and strategic planning. Task based modules have allowed activities in key areas e.g. personnel safety, fire and pest management, to be conducted with minimal delay in data integration. The FcMapApp was developed primarily in-house for use on an Apple platform with integration suitable for use in an Esri Arcmap multi-user environment. Primary data elements consist of vector geodatabases and raster tile packages and can be transferred to the user through direct and indirect mechanisms. Data synchronisation elements allow the changes made by the user to be integrated into the source datasets whenever the user is within range of the preferred mobile phone network.

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1. BACKGROUND

The Forestry Corporation, NSW (“the corporation”) has been managing environmental sustainability, tourism and renewable timber production in NSW’s State-owned commercial native and plantation State forests for more than a century. Environmental conservation and community recreation are balanced with timber production and access for other primary industries such as grazing and beekeeping to ensure that the forests sustainably deliver multiple benefits to the community for the long term. The corporation produces around 14 per cent of Australia’s timber annually and is a major player in the Australian wood products industry, which employs 22,000 people in NSW and adds \$2.4 billion a year to the economy.

The corporation’s Softwood Plantations Division (SPD) manages more than 230,000 hectares of pine plantations in the central west, south and north of NSW which is Australia’s largest softwood plantation estate. This is in addition to the 40,000 hectares of hardwood timber plantations managed by the corporation’s Hardwood Forest Division (HFD) which also has stewardship of two million hectares of coastal native, cypress, and red gum forests.

The development of a field-based data collection system has allowed management of forest related assets in remote areas where a direct connection to the organisation’s data storage network is not possible.

2. PROBLEM SUMMARY

With about two million hectares of plantation and native forest under management, the corporation required a robust solution that was suitable for data collection and attribute management in isolated areas with minimal or non-existent mobile phone network coverage. Additional requirements included the ability to work offline using a portable device which could be carried safely in the field, whilst also being flexible in use irrespective of location. Feedback from potential users highlighted the need for the development of individual task-based modules to undertake regular functions in the fields of pest management, fire prevention and containment, management of flora and fauna, and site-based planning for harvesting and re-establishment operations.

3. ISOLATED ENVIRONMENTS

Managing the corporation’s plantation resources has presented staff and management with several challenges due to the isolated nature of the estate (see figure 1). These factors may be summarised and include:

- Access restrictions due to the existence of minimal / incomplete road networks,
- Mobility restrictions within sites,
- Incomplete communication coverage (mobile phone - see figure 2 /corporate radio network),
- Proximity to medical evacuation services, and
- Difficulties in maintaining key infrastructure.

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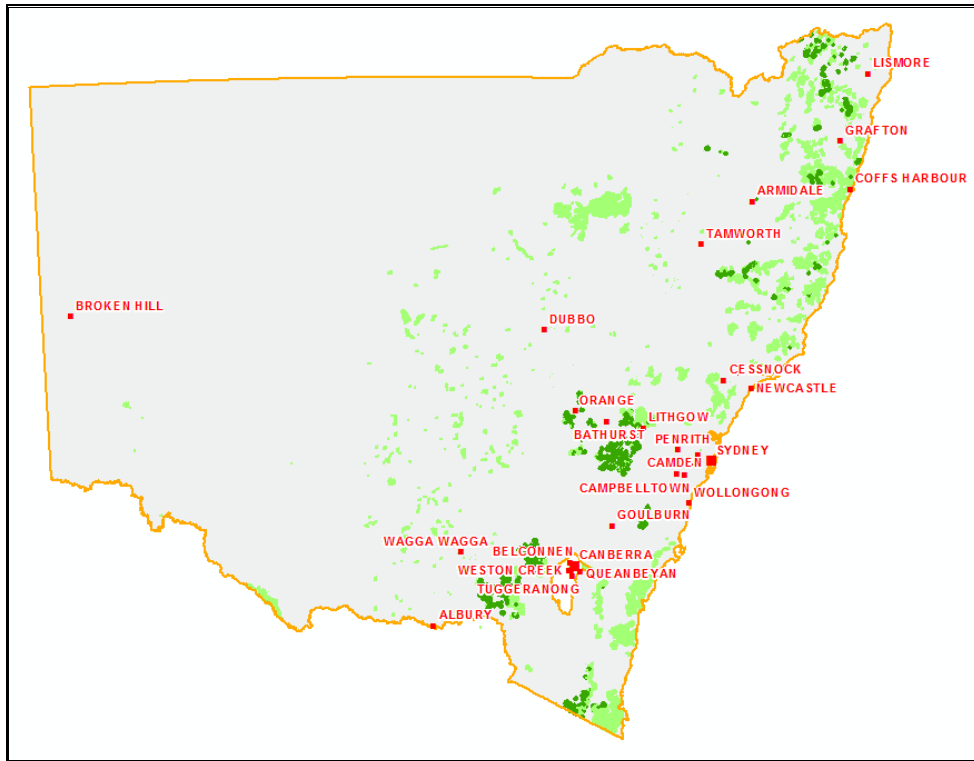


Figure 1: Map of NSW displaying state forests with plantations highlighted.

Mobile phone availability within the corporation's estate is variable and may be influenced by the proximity to the phone tower, obstructions within the line of sight, and the characteristics of the vegetation near the device.

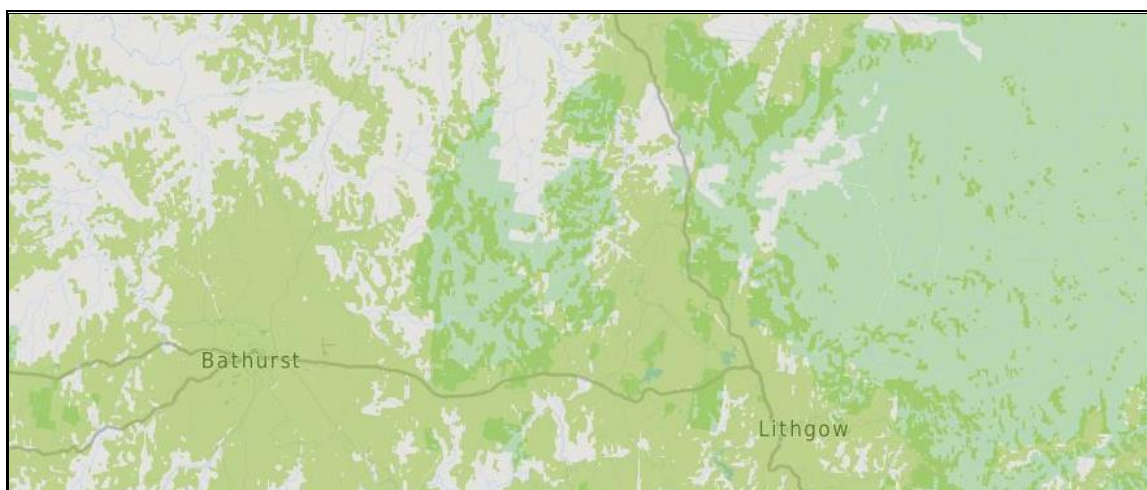


Figure 2: Mobile phone coverage map of the area surrounding Sunny Corner and Newnes state forests.

4. DEVELOPMENT

During 2012, the corporation commenced investigation of a map-based application (now referred to as the FCMapApp) for use on mobile electronic devices like smart phones and tablets. The aim was to develop an app that would complement operational planning processes and allow real-time capture of spatial data that could be stored in a central database and then made available to other corporation staff and contractors.

Several options were investigated for platform and operating system stability, with future development maintenance and integration into existing networks and databases also assessed for compatibility. These assessments resulted in the Apple iOS environment being chosen as the app platform with integration into the corporation's ESRI spatial framework also being a requirement.

Developing the app for use within the Apple environment required programming staff to develop expertise in several iOS related software suites that included Xcode, Swift, CocoaPods and Alamofire. These provided a solid development environment and programming language that enables management of external libraries, task integration and networking. Data transfer mechanisms investigated included those with direct and indirect network connections, with the ongoing maintenance of temporary storage platforms also considered.

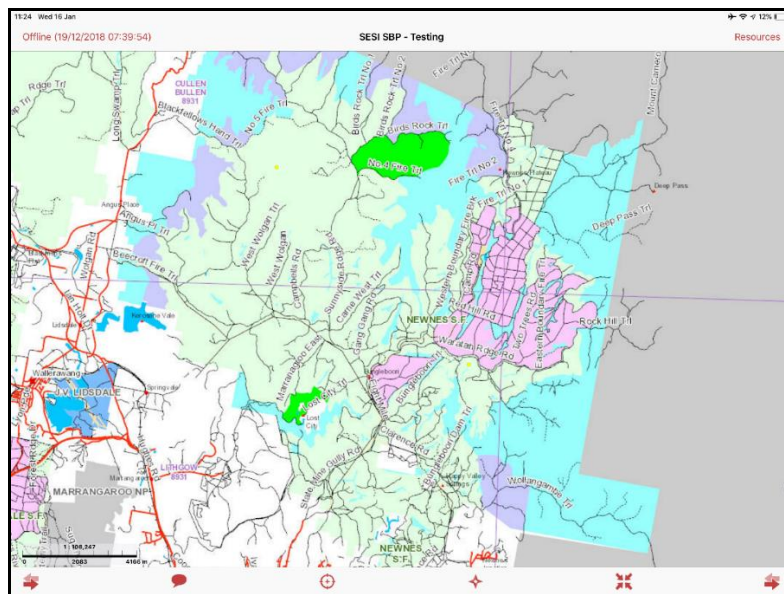


Figure 3: FCMapApp with base map

Three versions of the FCMapApp (see figure 3) have been developed, each providing different viewing, data integration, and data collection and editing functionality. The base version has full access to all modules with an “RT” version available for contractor machine tracking and an “LT” version that provides viewing capability only.

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The FCMapApp has been developed with the following toolsets and functionality as shown below in table 1.

Table 1: FCMapApp tools and functionality

Theme	Capability
Networking	Ability to operate online whilst connected to the corporate network or offline using an “offline” geodatabase.
External Data / Display	Arcmap raster tile packages and runtime geodatabases can be added and stored on the device.
Location search using coordinates	<ol style="list-style-type: none"> 1. MGA 13 figure grid references with utm zone, 2. WGS 84 <ol style="list-style-type: none"> a. Decimal degrees <ol style="list-style-type: none"> i. Degrees with decimal minutes ii. Degrees, minutes with decimal seconds b. Six figure grid reference (within screen area)
Location search using features	<ol style="list-style-type: none"> 1. Forest roads, 2. Other forest features eg fire towers, compartments
Location service	<ol style="list-style-type: none"> 1. Scroll to present position using GPS 2. Screen tap displays the following <ol style="list-style-type: none"> a. Coordinates b. Topographic map name c. Screen scale d. Distance to GPS location (if turned on)
Collection / editing tools	<ol style="list-style-type: none"> 1. Collect points, lines and polygons using the GPS coordinates as well as drawing on the screen with a stylus, 2. Feature editing for geometry and attribution
Database tools	<ol style="list-style-type: none"> 1. User settings 2. Database setup

Modules for the FCMapApp can be classified into six main themes as shown in table 2 below with each of the individual modules being designed to enable completion of position related tasks. Field workers involved in stewardship and fire management would utilise the functionality of the ForestFireTraining module when undertaking fire training. This allows the training data to remain separate from that collected using the ForestFire module, which is used for actual fire related incidents.

Table 2: Modules currently in phases of development

Whole of business / Unspecified	Ecology	Fire Management
Aboriginal Heritage CIFOAHarvestSupervision CIFOAMarkup CIFOAplanning FCMapReg ForestHealth	Biodata BiodataHabitat Biodata incchecker CIFOABiodata FeralAnimal	ForestFire ForestFireTraining HazardReduction MakeGoodMakeSafe
General Generic NFSI Recreation SESISiteBasedPlanning PDContractorSilv WaterMonitoring	Hardwood Forests Division	Environmental Protection Authority specific
	HarvestingSupervision Planning QAAAudit RoadOperations TacticalPlanning TacticalPlanningCoastal TacticalPlanningWest	CIFOARegulationEPA
		Softwoods Plantation Division
		HarvestingSupervision Roding Silviculture SiteBasedPlanning

Several of the modules have been designed to allow divisional planning tasks to be undertaken with location specific differences also being catered for. Within the hardwood forests division, the tactical planning components have been separated into “coastal” and “west” due to their specific requirements.

The FCMapApp also allows for the regular collection of point data from all native forest harvesting machinery. This allows the corporation to precisely map each machine’s location and ensures that harvest plans are being strictly implemented. This data can be accessed via a module that has been specifically developed for the NSW Environment Protection Authority (EPA) for use within their regular operational audit cycle.

5. USER WORKFLOW

The FCMapApp has been widely tested, used and accepted across both corporate and contractor workforces and has a minimal training overhead. Basic operations can be undertaken after only two hours of training in the field.

Initial user setup requires site selection in Arcmap and the creation of raster tile packages and, where applicable, runtime geodatabases. These may be transferred to the device via iTunes which is used as the primary interface for transfer of tile packages and geodatabases. Alternate transfer methods include the use of dropbox, and via AirDrop for transfer between devices.

The FCMapApp has been designed primarily for use offline in locations where connections to the corporate network are not possible. This does however require the user to have network connectivity to enable an offline geodatabase to be initially created. This will be module and location specific based on the user's task related requirements. Once created, the user may work offline within the area of the database, collecting new features and editing existing ones. The number of features affected by these edits are displayed in order to assist the user with internal quality assurance of the task. Synchronisation with the corporate database requires reconnection via the mobile phone network where the user's edits are uploaded, and new edits downloaded to the device.

Limits have been set within each module in relation to the maximum geographic area for each offline geodatabase. This feature optimises the synchronisation by minimising required database connection times.

6. CONCLUDING REMARKS

The development of the FcMapApp has enabled the Forestry Corporation, NSW to integrate field-based data collection activities with existing forest management operations whilst also providing a sound basis for tactical and strategic planning. Task based modules have allowed activities in key areas e.g. personnel safety, fire and pest management, to be conducted with minimal delay in data integration. As a result of interest from external parties, the corporation commenced a scoping project in late 2018 to determine the feasibility of developing a commercial version of the MapApp for customised integration into the ESRI GIS and ArcServer environments. Anticipated developments in 2020 include the capacity to accommodate vector tile packages, supplementary reference datasets, and the creation of additional task-based modules.

BIOGRAPHICAL NOTES

Anthony is one of the Spatial Systems Coordinators for the Forestry Corporation, NSW and works in Bathurst, New South Wales. He has been with the Forestry Corporation for the past seven years and previously produced topographic maps for the NSW government. His qualifications and professional interests include cartography, environmental science and ecology, and hydrographic surveying.

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