

Outline Contributing Project

Research

I. Background

Ford Grant

~~Feb~~ 3-58, decided come here. Decided work in w-n law relevant here, so wd. gather data + here, operate stat-ly & ~~write~~ ^{write} up here — thus deepen project, permit greater insight. [This aspect a success, concepts of problem grew a good deal in result of more info.] Quid pro quo — Mo. gets my Calif. experience, I get oppy ~~finish~~ ^{improve on} project.

II. Concept of study

Wn law, a priori, wd lead to malalloc-n, of wtr, & cap & land. Hist. priorities; low xfrability; premium on premature excessive claims; hi legal costs, vagueness, "perilous equilibrium" Persuasive defenders concede this, & past abuses, but allege all ironed out now. S.T. Harding.

So can't rely on past evidence, nor a priori, nor scattered e.g.s. Calls for close study of one area, today.

Selected S.J.V.

III. Approach

Find areas of shortage & surplus — near each other

Find MP of wtr in each.

Find x ptn cost

See if = ~~equilibrium~~ violated; & if legal barriers responsible.

III. Some major defects of wt law, in hypoth, to test.

- a. Ripn claims vague, unknown.
" " unused, block other use.

b. Approp. doctrine ~~makes you claim~~

Claim too much, too soon.

Premium on keepg surplus, once had - no cost, & can't sell it.

- c. In flexible - stick with historical priorities.
Dynamic: make you dev. mgmt wth while better ones undervd. This coupled with slow settlement, makes corn-hog cycle.
- d. Cd. more most of this 2 ways:
 1. Divergence of MPs (net of xptn costs)
 2. Lost gains of integration ~ overall view.
 3. Wastes of poor synchroniz-n.

IV. So major work is:

a. Master details of wt law - as applied

Work in Wt Rts Bd; & now analyze decisions

Confer wth masters (incl. BR, Lemoore, & I.D. masters)

~~or~~ Investigate mkt in MWC shares.

Analyze political forces

b. Pinpoint areas ^{of contrast} where wt law seems to be major obstacle to ~~smaller~~ ^{cc. xbr} ~~smaller~~

from surplus to scarcity. (This leads to considering swaps, integr-n)

c. Determine MP of wth, & schedules, in above areas.

Schedules from AES & studies, various crops.

~~MP now from:~~

IV (cont.)

Current MP from:

Water let run to waste (e.g. shown on Tual. during 11 mos. of yr by diversions less than during Aug. w. lowest flows)

Well depths & costs.

Economy in handling wt.

Including adequacy of storage on controlled streams - job 2. (But note contrast of long run) (I short run results)

Correlation of output & wt supply - job 3

Mkt xfers of wt

Dry vs wet l.v.

Willingness to assume costs of importing

Known applications, cfd to AES schedules

Local gossip

State & BR studies

Big problem, some areas, is wt quality. Need work on that.

Ambiguities, is imptnt, so big attack, confirm results many ways, leave no doubts.

d. More gain from Integration.

Kaweah - losses from disintegr-n.

A variability?

Risk not shared, but concentrated on jrs.?

Storage + has blocked?

Great A of distribn costs. Crossovers, etc.

Rigidity - wt to lower users.

9 valley streams.

Correlated, big ones are.

Gain is from integr: little ones with big.

And using inter-washed storage.

And planning network as whole. Now parallel reverse canals; crossovers, etc. And wt quality. The more dimensions, the more gains.



e. Measure, or at least describe, losses from lack of synchronization of compl. dev.s. (This is related to gains from integrn, above)

Involves more than wtr law, but is bound up with it.

First conceived problem as freeze of scattered settlement by fixed wtr rts.

Now see over expansion, thru recharge of ground wtr over wide area.

Enormous imports for recharge.

Waste in distrib. nets. Superposition of anachronistic instns & techniques.

Constructive side of study. To devise more ec. system.

Nec. aspects: 1, create mkt analog at given pt(s), net of xptn cost.

- 2, Price for distrib. net.
- 3, Multilateral, multidimensional coordination.
- 4, Dynamic devmt process, synchronize.

1, Submit demand schedules

2, MC pricing. Study thy, & power pool's & programming.

3, Transportation model of linear programming. etc.

4, Link with 2. By price & tax's, turn devmt on & off.

Incidentals.

Keep up with lit.

En. lit.

B-C analysis

~~By-products~~

By-products, multiple purpose, commensurability & reconciliation of conflicts.

Risk, probability analysis.

Mo., ~~pre~~ prepare study here.

Previous work & present outlook, 5

B, If study is expanded, 2

Integrate variability with distributive analysis. & ask how volty affects intensity of land use, as well as unit costs of distribn, & hence how to distribute variability in light of these relationships.

How far is it feasible to carry integration, analytically & fully? How far carry synchronism?

How treat anachronism with water?

~~Put equal values on water in diff. uses~~

Incorporate wth quality into analysis.

Work of others - ^{Shortcomings of wth have raked over several times.} Few ecsts. Lawyers, engrs, administrators, & interested parties, w/o ben. of tools of ec. analysis, & often w/o ecsts overriding concern for genl welfare & overall eff. of res. use.

Previous work & present outlook, 4

Future work (cont.)

4, Manipulate data (cont.)

5. More comprehensive analysis of the low flexibility problem. Xfr not, ^{absolutely} impossible, is simply ^{very} difficult, so does not occur until high pressure builds up. As micro adjustments are frustrated the demand for macro-adjustments is accelerated. Leapfrog pattern results. Adding to this is courts' failure to acknowledge diffs. of degree. Waters are either 'used' or 'not used'. Wts seekers ~~to~~ pressure until find "unused" wts, convey at great expense & w/o any intr. past ~~under~~ wts in varying degrees of underuse. Adding more is inflexibility - one wts are got, cannot return. So cts reserve wts for "ultimate" needs, seekers go still further. Poses dynamic problem too.

B. If study is expanded

Math-stat techniques to determine optimal adaptation to unpredictable wts & variations.

Techniques for handling more variables simul., optimizing widely.

Commensurability:

recreation values

"2 dry beans". External ccs.

Analysis of complex interdependencies. Techniques for, apply to wts res. problems.

See how far can carry intr.

Dynamic aspects, growth of distributions

Previous work & present outlook, 3

Present Outlook (cont) - work remaining for future.

3. Sharper Concepts (cont.)

4. More ~~evaluation of potentialities~~ ^{manipulation of data from} field studies to evaluate actual practice & potentialities

Est. aggreg. net bens possible from jt. devmt of several streams

Apply overall analysis to CV, [xptr model] suggest likely lines for unified overall devmt, & ~~est.~~ (under model wth instrs), & est. ^{net} benefits ~~therefrom~~ from the changeover

Summarize inequality of wth distn in Lorenz ratios or variances.

Where integ'd devmt has taken place on small scale, as in I.D.s., cf. benefits as vs. unintegrated systems

~~Effects of prioritis system on predictability of~~

Express in meaningful quantitative way the scattering of invd among dry yrs.

Refine correlations of crop output & wth input:

- a, Better wth input data. from power cos.
- b, W_i
- c, Seasonal aspects wth supply.

Previous work & present outlook, 2

Integrn of major streams, effect on variability.

Discovered gains are more, the more dimensions can consider: quantity; timing; storage sites; quality; multiple uses.

Major findings to date

Copy from statement of 10-23-59

Add item 7, p. 8, Ford outline

Present outlook — i.e. work remaining for future.

~~Are two projections, one premised on present support~~

A. Plans for work under present support

B. Plans for expanded study under Guggenheim or other grant.

A. 1. More data

Costs of storage dams

... .. underground recharge

MP of storage capex. used for flood control.

Salinity tolerance limits

Data from power cos (via College-Industry Exch. Program?)

Pumping histories for studies of history of wtr appln. for MP.

Productivity of possible diversions interwtrshd.

2. More stat. methods

Clustering-of-deficits index (& apply it)

Evaluate commensurably reductions in variability of supply — i.e. how much money is a given reduction worth.

~~And~~ Evaluate predictability of wtr supply (as vs. more variability) under different systems. (the variability is probably = by input)

3. Sharpen concepts, more comprehensive optimizing

Define MP of ΔL storage, not in terms of Δ const. annual supply, but something more comprehensive: flexible pricing, & multiple use

Contributing project:

Previous work & present outlook

Previous work by others, too much to enumerate is tangential, nothing is direct. ^{see p. 5} ^{Hutchins too legalistic, others too engng.}
Analyzed w. law a priori, postulated several aspects lead to unrec. results: ^{nts. based} ^{hist. priorities, & obsolete}
wasteful standards of water conservation (so why store, e.g.)
low xfrability, premium on premature inflated claims, ^{legal costs; vagueness: "perilous equilibrium"}
inadequate security for some, & too much for others; ^{nts. expressed in const. rates of flow; breaks up w. users into}
parties w. conflicting interests, & myopia, thus disuniform, ^{neighboring mass. point benefits.}
examined field practice, which modifies law. Short circuits, perilous equilibria - but

no basic solutions. MWC stuck xfrs. Sub Rosa sales, on fringes of legality - LTID to Gamboyy.
(Better to present this here as already done, otherwise faint, hearty, think too high)
Examined xfrability which does occur. Discovered problem is far more complex than simple (over)

Dynamic aspect: reach out for remote wtr before devg local "captive" ones (opp. of
often adv.) leads to cycle of overdevmt. (as well as static simple wastes). In conjunction
with lack of synchronization of comply devmts, which is a problem anyway.

Msd MP's in field, to see if diverge

Means of msrg MP's: - - - - -
Carried it back to raw wtr before storage. - tho this is more a future job. (One means of msrg
MP's w. conservation expenditures, but must include long run ones, & they are perverted.)
Means of msrg ~~xfr~~ conveyance costs:
(Best, chose situations where $x_{fr} = 0$)

Estd. other gains from xfr, integrated devmt, precluded by wtr law.

Described cycle - here, effort is just to establish cycle & its relation

to wtr law, no effort to msre losses, too complex.

Worked out evolution of MC pricing over time, with distrib. nets, to max. benefits from works both
immedly & over time: to encourage quick ~~compact~~ ^{settlement} ~~and~~ ^{free use of facilities in early}
~~Waste of law: courts insist users must have enough~~ ^{life, & evolve to enforce es. of overloaded facilities}

Analyzed ^{layouts &} ~~ops~~ of several wtr masters
Catalogued possible gains from inter: give a few e.g.s - : long xfrs by bidding bull effect, min. xfr cost; use cheapest
Investigated xfrability thru mkt in MWC shares. ^{storage sites}
Catalogued major diseconomies in wtr system of S&V - e.g. parallel canals carrying wtr in opposite directions,
More losses from ^{of which there are several; areas adjacent of contrasting surplus & shortage; contracts in} disintegration of one river. (Kameah) ^{stage of returns to storage on}
Divergent MP's & distribn costs ^{adjacent streams; etc; rice}
& variability ^{in south; xfr wtr from}

Develop analytical tools:

Variability of flows (to est. potential ^{define min. variability & evaluate current practice} ~~reductions in variability, & define~~
To det. stage of returns reached by storage capax. on variable streams
System of bidding
flexible pricing & ^{allocn.} ^{These are devmt of the prototype.}
MC analysis

blockade of xfr. Obstacles are great enough to prevent micro-adjustments among neighbors. Law does not recognize continuous variation, or diff. of degree. Wt is used or not. So needy ones reach out to wts "not used", leaping over those merely underused. Result is an overlapping pattern. ~~xxx~~ Pattern is then frozen irrevocably.

"Flexibility" is one problem, means continual adjustments in perp.

"Xfrability" is another. ~~One~~ Xfr is possible, but only on terms precluding future xfrs.

Leading to ^{degree of wild} irrationality that wd never be tolerated in the mkt for ladies hats or perfumes chromium-plated roadsters.

Justification, 2

Quote Brinegar Beuchman & Southworth. Mention calculus & gravity.

Field studies nec. bes, despite obvious diseases inherent in law, & qual recognition of abuses in past, some competent observers allege all is now ok. The law is modified in application & sometimes ~~to~~ short-circuited; and ~~some~~ ^{influential} ~~some~~ authorities, while conceding that abuses have prevailed in the past, now allege that these have been corrected

~~Life than risk loss of human experience~~

Devise model to shoot at - has become accepted technique, in field w/o lab experimentation.

Field study nec. bes some who concede unrec. propensities of law, & past diseases, interpret these just as grow's pains, allege no problems now. Others allege never were any problems. And bes no one, pro or con, knows how great ~~problems are~~ diseases are.

New tools nec. bes are lacking. Has bc province of lawyers, engs, admns, ~~interested~~ Ecsts neglected.

Ec. model nec. as norm for criticism - ~~except in~~ "diseases" are meaningful only in relation to some superior alternative. Also as target for leg. reform.

Ecsts of actual value of apply'g model ~~are~~ desirable to appraise its value.

Approximation by familiar instans nec. to make practical. Indeed when one reaches this stage one can regard the pol. problem as an ec. one - how much ec. perfection to sacrifice to achieve actual application

Recommendations for N.C. States. Payoff of whole study.

contributing project: Justification - enumerate ~~as~~ objectives, (implicitly), justify each.

Lyricize some on variety of Cal. experience, evolution thru long history.

NCT 44 concerned w. reconsideration of water law & policy from viewpt. of ec. use of
wk. Due to Ag demand for wtr, bringing out need for means of arbitrating among competing uses.

Calif. has bn in this situation for a century; ~~has experimented w.~~ present wtr ec. probly good
~~picture~~ forecast of future situation in humid states. Latter + hrs fortunate, oppy to survey this
~~precedent, anticipate problems. Is impnt to future, bcs instrs tend to jell, can't~~ ^{try new ideas}
~~Cal has experimented w. wide variety~~ w/ creating vested interests resisting change.
So take advantage of experience elsewhere.

Calif. not only longer hist., & more ^{sheer} quantity of irrd. land & diverted wtr, other
advantages:

Physical variety, ^{From humid to arid, like NE region. Get rainfall data.}
[Includes purely intra-state situations
corn, wheat, fruit, dairy, etc, feedlot.]
& ~~some~~ variety of interstate.
Evolution of law, from ripn to approp, over many decades, tried many shades of
combo. of two, experienced all the trials in shifting from one to the other.
Much activity, hence more experience to draw from

Early progressive State

Variety of law & instrs: ~~from~~ individ fms to statewide wtr plan to Interstate Colo.
Compact. MWCos, ID & Co Distrs, MWDSC, 2 big urban centers w. 3 big wtr systems, State DWR
~~Ripn~~
w. \$14b program, 2 fed agencies w. statewide plans
Rural-urban conflict.
Been thru cycles

Multipurpose projects, experience in complication of integrating devmt. reconciling conflicts
Superposition of new on old, several stages. experience w. problems.

Advantage to study by someone supported from outside region, beholden to no one there.

Advantage to study already well advanced, ^{only needs a little supplemental irrigation now.}
^{one yr Ford Grant, 1 1/2 yrs Mo. support}
^{background has given latitude for emphasis}
~~has a conceptual framework~~ ^{basic conceptual problems}

Not only much mtrl already collected, etc. But study, ^{methodological problems, framework of analysis, stat. techniques.}
theoretical approach not always possible within limits of Exp Sta., but which most works
cust agree is desirable.

Objectives:

1. To ^{and summarize} analyze ^{from an econ. viewpoint} the major elements of water law, ^(const., statutory, & judicial) ~~(const., statutory, court)~~ administrative practise, & other prevailing instns & customs, ^{currently} controlling use, allocation & devmt of water resources in Calif., both currently and historically, singling out for special attn those elements that seem likely to lead to uneconomical results on the basis ~~both~~ either of a priori analysis or field experience.
2. To ^{define the nature and} establish ^{the extent of} ~~the extent of~~ ^{order of magnitude of actual} ~~actual~~ diseconomies in the study area, the San Joaquin Valley and areas of linked water economy, relating these to elements of water law with a view to suggesting improvements in the law.

Objectives

1. To ~~analyze~~ ^{analyze from an econ. viewpoint.} ~~with law & other instns & customs controlling use, allocn, & devmt of wtr res. in Calif,~~ ^{prevailing & historical} ~~both currently & historically. summarizing it as concisely as possible for purposes of its ex. aspects~~ ^{and specify disecs. inherent in these & other prevailing instns.} ~~and singling out for special attn~~ ^{these.} ~~those aspects that seem likely, upon a priori examn,~~ ^{to lead to conc. results, or are alleged by competent} ~~observers to have~~ ^{done so.}
2. To evaluate the ^{econ.} performance of ~~prevailing instns~~ ^{these.} in ~~practise~~ ^{practise} in the SJV, both ~~currently~~ ^{observers to have} ~~and historically.~~ ^{done so.} with special attention to the diseconomies.
3. To develop such analytical tools, ^{and solution to generalized problems} as prove necessary most effectively to analyze the performance of water systems.
4. To posit a model system ^{of institutional channels within which market forces can operate to} ~~of economical~~ ^{achieve an} allocation & devmt. of water, ^{the model to serve} as a norm against which to measure the ~~actual~~ ^{actual} performance of systems, and ^{target} as a prototype for legislation. ~~the aim towards.~~
5. To sketch the major changes the model system wd imply for SJV, & est. the net ^{benefits over the present dispensation, with a view to determining whether such changes wd. repay} ~~the costs of transition.~~ ^{the effort they wd. entail.}
6. To approximate the economic model within the framework of law & custom in the United States, ^{& c. water} ~~probably by extension of the public utility concept, as exemplified by existing irrigation districts~~ ^{in refashioning their water instns} ~~due regard for problems of transition.~~ ^{the}
7. To apply the ~~in the light of Calif.'s experiences mistakes and achievements~~ ^{in refashioning their water instns} ~~the~~ ^{the} ~~achievements and the mistakes, of Calif.'s century of intensive and varied experience~~ ^{the application of different systems of water law.} ~~with water law.~~ ^{and its applic.}

Procedure, general

Research is conducted by proj. leader assisted by grad. students.

Objective 2: Primary data is secured by field work in Sfv, interviewing water users & administrators of
wtr distribg orgns

Field survey already completed, forced by one yr ^{Ford Fdtn} ~~from~~ Free Res. Fwsp. to Proj. Ldr

Study history, has:

- a, Rts + hns established
- b, Object to get experience w various laws
- c, Dynamic developmental processes

Procedures (use present tense throughout)

1. Wtr code, leading commentaries, ct. cases, adm. rulings of WRB, interviews w. responsible administrators, lawyers, judges, litigants, engs, etc. ^{commentaries}
- A. ~~Set up criteria for spotting disease~~ Lay out essential elements of law, & admin. practice. ^{Survey vast lit.}
pro & con. ^{Basic sources for law, leading decisions: --- For adm. practice, compare w. WRB's ed., study decisions & procedures.}
~~from this capture essence~~ Reason out, ^{a priori} probable results of applying law, itemize major diseases likely to result.

Thus far, ^{in this process} several major diseases have emerged: - - -

And many minor ones.

Is not complete list. Is proposed thru continuing study of court cases & admin. procedure to revise list if called for.

Examine adm. practice by consultation w. administrators, analysis of ^{criteria followed in their} decisions

Note evolution over 100 yrs, & uneven impact of changes on diff. sections, hence need for continual attn to gen. what law is actually in force at given place & time.

Note informal arrangements outside law, short-circuiting law.

Summarize principles, ^{expressed} implied in ct. decisions; & in Statute.

Are several sources of "law": Fed & State courts, Statutes, etc, adm. practice at several levels.

And all degrees of pervasiveness. Some dead let, some new & only in process of application, & all in continual evolution, ^{or vacillation} so a principle is often abandoned before has ever been thoroughly applied.

weight them by length of appl., etc. In laying out ex. principles of law must also, ^{also, power given & distribution not confused or cut off.} also, ^{also, its to gen. power, some criticism as in. wtr etc, no cost} also, policy of pricing multipurpose outputs from non-ec. ^{probably pol. bases, shd be analyzed.}

Add to unec. aspects of wtr law: need to comply w. acreage lims. ^{mutual obstruction,}
Failure to designate one agency to coord. major depts, result overlap, ^{shd be analyzed.}
& non integration & non synchroniz.

2 elements to norm: allow from given source pt; & distrib. nets. Only the former is necessary in criticizing wtr law?

MP: wtr ~~shd~~ shd all =

MP: capital improvements also shd all =. Sometimes easier to figure these directly, even tho cd. be subsumed under MP wtr somehow, perhaps. (Bes if MP: wtr $\neq$ then MP: cap $\neq$, since they are substitutes)

Procedures. 2

Evaluate ec. performance. In respects that it seems likely low wd. neglect. make wrong.

2. Establish that said defects of low & adm. work out as seem they might.

Rough standards of performance: = mgul, ^(later refined) minimize ^{aggr.} variability; flexibility; roughly = distribn of risks inherent in variable stream flows; full utilization of by products; full benefits of ~~conjunctive dam~~ integration, both spatial & ^(and/or an uncertainty) temporal.

To see if wtr = mgul, ^{require} means to est. MP wtr. These are:

Also requires est. conveyance costs between points of divergent MP. Easiest way choose distribn of same stream, no conveyance cost. Also are instances wtr movg to low MP from hi, req. conveyance cost.

To see if flexible, examine means of xfig wtr after once subjected to claim.

Sales of shares in MWC.

Extinction of rts for nonuse

Direct sales of wtr (not rts)

Sale of permission to pump wtr

Xfig by sale or agreement within large intd systems (BR, 90s) (Kings R?)

Allocation of rip. rt to subdivided lands? (Empire W. Sids)

To see if min. aggr. vblty, ^{chose best R system, for which complete data,} compute aggr. vblty in system, of w. min. possible in view of natural vblty of R.

To see if distrib. vblty, compute it for each distrib.

Contributing project: Procedure - links to objectives

Analyze water law - does it establish instl channels via which ex-firms can operate to allocate wtr to best use, & incentives are created to develop wtr res optimally?

Measure MP of wtr, neighboring areas, & xfr costs, get net diff of MP, see if factors other than eng-g costs of xfr are obstacles. To isolate this factor, cf. areas on same stream, xfr cost = 0, and also both have same stream storage (or lack of it), is no gain of more storage on hi MP stream as alternative to xfr. (altho failure to store is also a fault of law, so $MP_1 \neq MP_2$ is still sign of diseq.)

Simple workable solution here maybe to of MPs at ~~diff~~ same times of yr in all cases. Develop analysis of variability to permit of & give meaning & reinforcement to above. MP varies seasonally. And MP to firm depends in part on storage.

A legit. obstacle to xfr wd. be if wd. be cheaper to improve supply in hi MP area by more storage. Maybe opposition of direction of diseq at diff seasons; also of long & short run diseq. Are still diseq, & must be handled.

Will treat separately of short & long run - i.e. of fixed vs variable and annual expenditures. Bes. motive of fixed invst. is often to establish wtr rts.

Current MC to conserve wtr is good more of MP; but long run MC is not, bes a, changing price & cost levels, conceptual problems, miscalculations, etc.

b, Motive perverted, to get wtr rts.

Cf. MP wtr at what point? Doesn't matter, only need to show diff. not comp'd by cost, or cheaper alternative. (& latter is equivocal, if not exploited, in a sense not cheaper) At any pt., at any time, is diseq. And the more pts & times, the more diseq of course.

Analyze decision & policies of Wtr Rts Bd, which in some more now by-passing etc.

Seek out & evaluate benefits from integrn.

Procedures. Objection 1 (p. 2)

~~the~~ In describing & eval'g law, to link ~~the~~ wth law & custom w. analogous
law & custom in other areas, thus broaden'g scope, & simul. singling out
of appln of conclusions,
what is uniquely attributable to wth law.

Procedures

3. Developing analytical tools ^{and solving generalized problems are} not a prime objectives of the present project, but ~~a~~ necessary incidents. The procedure therefore is to develop such tools ^{and pose & solve such problems} only as the need ~~becomes evident~~ arises, in pursuit of other objectives. As much as possible tools already devd by others will be borrowed. However note is taken of methodology. ~~However~~ ~~It is evident, however, that if new tools needed~~ ^{that need for which is brought too light during project,} fruitful avenues for methodological research ^{that need for which is brought too light during project,} too ambitious for the present project & are will be enumerated for benefit of other researchers.

See NCT-44 recommendations.

It is antic'd that ~~elements of doubt~~ will areas of intellectual uncertainty will be identified which will preclude the model from approaching perfection, even ~~to~~ in theory. Some of these will be too ambitious for present project to explore, but will be identified for future ref. (E.g. 2 dry bens)

(Antic. many tools I need already developed in other fields, so 'dev' tools may be partly just matter of looking for them.)

Some needed "tools" are solutions to gen'l theoretical problems. E.g. how far extend distrib. net

Some needs now foreseen are: (see NCT-44 statement)

Ees. of distrib. nets	{	How far extend distrib. net.
		How intensive build distrib. net (given parameters of scale es, etc)
		How lay out distib. net, (relating trunks & branches)
		How price services over time
		How synchronize w. depts of complements.
		How build in flexibility for future coordn. expansion.

Procedures

4. A model water system of instl controls ~~will~~^{is to be} be sketched out in some detail. ~~[Consumer sovereignty is assumed, and the system regarded as a means to achieve it.]~~ Criteria ~~for~~^{for} performance are specified, and a model devised to satisfy them.

The criteria are:

Consumer sovereignty.

= mgmt allocation of water, ^{among users, with due account of conveyance costs} & developmental resources among waters, including ground waters, in which principles are designed or accepted.

Flexibility: of allocation, as parameters change, & as new ec. principles are designed or accepted.

Priority of devmt so most ec. projects come first

Synchronize devmt of complements

Distributive equity - create no privileged classes

Compact settlement so as to minimize distribn costs

Coordn of areas & fns within as wide a range as possible on balance advantageous.

(determination of how far is advantageous is part of research)

Certainty of conditions on which water may be obtained, within limits imposed by nature

Minimization of ^{unwanted} variability in system, and optimal distribn of irreducibly variability among users.

~~The~~ Timing wth deliveries as much as ec. according to demand

Sufficient conformity with prevailing mres so as to qualify as a ~~target~~ target for actual legn & adm

Overall adm of underground aquifers as common facilities in the public interest. Recognition of ground water ~~as a resource~~

~~At this stage the gn. of political feasibility is deliberately ignored, in order to permit & encourage free & original exploration of ec. potentialities. The political gn. is introduced later.~~

Approach is to create channels w-in which mkt forces can op. Set up all aspects of highly orgd mkt. futures mkt, speculation, etc.

Procedure will break model into parts where possible, so no one need accept whole to accept one part. E.g. alloc-n of wtr can be treated as of one pt, then handling of distribn costs made a separate gn.

Previous Work

Objection 4.

System of pricing distrib. nets so as to affect location. Most network studies take location as given, but in fact it shd be considered a variable, too, & subjected to constraints reflecting its influence on distrib. costs.

System of flexible pricing, via advance contracts, for allocating variable supply.

Justification

NCT-44 is charged with a reconsideration, from an economic viewpoint, of water law in the North Central States. Need for this has arisen because growing withdrawals from limited water supplies, and the certain prospect of increased future demands, have brought on conflicts among rival claimants, and demands for public and private investment to develop and conserve waters previously regarded as unlimited. Thus the humid States are beginning to feel the same pinch that Nature long ago imposed on the arid ones, and to face problems with which the latter have grappled for a century.

~~Ours, then, is the historical advantage of a late start~~
so close by

It is our good fortune to have ~~this~~ the arid States' rich store of experience economizing on water within the framework of American law and custom. ~~Ours is the historical advantage of a late start.~~ Social experimentation is costly and, ^{its errors} oftentimes irreversible; ~~historical~~ the study of historical experience is cheap and non-committal. ^{Ours is the historical advantage of a late start. Nothing could be so useful as the} ~~The power of prophecy would be priceless as it is~~ ^{clear power of prophecy:} ~~unattainable;~~ but many of our future problems and opportunities are already recorded in the arid States' experience, an open book of information, dearly bought, now ours for the looking. ^{Intelligent self-interest} ~~We would be myopic indeed not to profit from looking hard & long.~~ There are Western achievements to emulate, ~~but perhaps more~~ ^{which} ~~important there are~~ costly mistakes to avoid, ~~This is the more~~ important because many of these, having ~~called~~ created vested interests to perpetuate them, are virtually ~~fixed~~ ^{irremediable} ~~irreversible.~~ ~~Only the~~ ~~narrow~~ ~~our relative freedom from such restraints gives us~~ an ~~Only the myopic self denial would not have us~~

It is our good fortune to have so ^{nearby} ~~close by~~ the arid States' rich store of experience economizing on water within the framework of American law and custom. ~~Social experimentation is costly and its errors often irreversible; the study of historical experience is cheap and non-committal.~~ ^{We lack} ~~the power of prophesy, would be priceless;~~ but ^{many} ~~but~~ many of our future problems and opportunities are already recorded in the arid States' experience, an open book of information, dearly bought, now ours for the looking. Ours is the historical advantage of a late start. ^{Social experimentation is costly and irreversible; the study of historical experience is cheap and non-committal.} ~~There~~ The West has achieved notable successes to emulate, and committed costly errors for us to avoid, the latter being perhaps the more important since many of the errors, having ^{propagated} ~~evoked~~ vested interests to perpetuate them, are virtually ~~incurable~~ ^{only} irremediable. We would be ^{only} ~~indeed~~ not to exploit our advantage by ~~looking hard and long at the~~ extended study of water law in the West. The recent Wisconsin Supreme Court decision in the Nekossa-Edwards Paper Co. case, ^{points out} ~~invalidating~~ the water permit system up that the humid States cannot forge ahead as though ~~they were~~ writing on a blank sheet.

The 68th General Assembly of Mo. indicated its desire for work of this sort when it passed House Resolution No. 51, ~~declaring~~ ^{resolving} that:

"a thorough study be made of the statutory law of other states pertaining to water & water use, for the purpose of guiding our leg. in enacting similar laws to conserve our state water supply."

Calif. advantageous to study for fl. reasons.

1. ~~Calif.~~ The historical evolution of Cal. wth law is ~~a fantastic present~~ is more relevant ^{than that of other arid states} to the current problems of the N.C. states in that Calif. ~~adopted~~ ^{the} rip. doctrine became firmly established early in its history and ~~then~~ has been struggling ever since to superimpose an approp. doctrine on it. It is true that ~~other~~ arid states in the plains tier have long-standing riparian elements in their water laws, but ^{"Cal. ... became the battleground"; in Roy Huffman's words, "where many of the conflicts between the approp. & ripan. systems were most violent."} legal historians ~~quickly take~~ the Calif's lead'g case of *Lux v. Haggin* (1885) is ^{known as} the classic expression of rip doctrine in the west, ~~& refers to~~ modified riparianism is ^{Nearly 1000} ~~an estimated 800~~ of Calif's irrd. land is still served under rip. rts, using more than ^{that proportion} ~~800~~ of the water, & casting a shadow of legal ^{uncertainty} ~~doubt~~ over much more than 80% of the wth in the state. & subjecting an even longer share to the danger of ^{recapture main} ~~latent~~ rights. The problems of superimposing ~~an approp. on a rip. system~~ ^{no deapied Calif since 1913, when state filing of approp. claims began.} with economy of water.
2. The sheer volume of Calif. experience ^{time-span of historical} far surpasses that of any other arid state, in terms of irrigated area, water diverted, and, above all, value of irrd products. This is of great importance in evaluating the workings of water institutions: ~~even a~~ the statistical universe is large enough to give more significant results. For example before 1920 the ~~number~~ ^{volume of litigation} of water ^{in disputes over water in Calif. averaged 7-8 cases yearly.} ^{important} The Calif. experience, ^{at least} has as deep a time-dimension as any, and longer than most, going back ^{to the} Spanish padres of the 18th c. Efforts by the state to develop a comprehensive state wide ^{as far as} ~~water plan~~ go back ^{to} 1813. Within this time-span Calif. has witnessed ~~the~~ a rapid succession of techniques and institutions which afford an unusually rich experience in the important process of superposing new ways on old, & ~~has~~ ^{clear} experienced more than once the boom & bust of rapid land development.

3. Calif. affords a greater variety of experience. In respect to ~~crops & products~~ ^{grains for human & animal consumption, both} it has strong ~~an~~ feeder & dairy operations, like the N.C. region; ~~along w. a wider~~ ^{irrigated & dry farmed} variety ctn, like s.e. Mo.; ~~a little maize~~ ^{growing corn acreage} & a great ~~volume~~ ^{volume} of small grains, both ~~irrigated~~ ^{irrigated} & dry farmed, for human & animal consumption; wide pastures, both dry & irrigated; along with an unequalled variety of truck, vine, & orchard crops.

In respect to physical conditions its farming areas range from arid to humid, with a large acreage ~~in between~~ of intermediate rainfall where farming antedates ~~irrigation~~ & "supplemental" ~~irrigation~~ is as much an issue as it is here.

In respect to institutions, Calif. ^{in 1887} produced the first workable ID law on which ^{91 CWDs, & 18 WCDs, under 30 good state enabling acts} most others are modeled; ^{in 1911} it had ^{over 160 irrigation IDs,} more land in IDs than any other state, & ~~has several~~ ^{has several} ~~a score of other kinds of District organs to choose from.~~ Calif. also ~~has several~~ ^{has several} ~~hundred~~ ^{hundred} the Mutual Water Cos, of which it has several hundred, about as many as Utah (whose ~~irrigation~~ rests almost entirely with this method). Calif. ~~irrigation~~ A third large share of Cal. ~~irrigation~~ is by individuals, from surface & ground waters. Calif. is the only ^{part of Am.} ~~state~~ to my knowledge with ~~land~~ where the State Gov't has undertaken land settlement projects (Newham & Delhi). ^{It is one of the few places where commerce} ^{It has some of the best commercial ~~irrigation~~ with cons. still opp.} Calif. has Federal projects, both small (Orland, Tule L.) & large (CVP), both ~~Army Engs~~ ^{its shared} with ~~ample~~ conflicts among Federal agencies, & between state & Federal interests. Calif. ~~pushed~~ ^{has} interests waged (8 lost) & the most all-out battle against ~~Federal~~ the 160-acre law, & have participated & are participating in a large share of the leading cases in State-Fed. relations. Calif. ~~may~~ is the only State govt. to enter on ^{State-financed} reclamation projects, which may possibly with ~~a~~ millions of State dollars already invested in the FRP & a \$1.75 billion bond issue before the voters in Nov.

In respect to urban-rural relations, Calif. contains the 2 largest cities
 & several of the other large cities of the arid west, ^{org'd into three major urban leagues,} all competing for water
 with agric. & also coping with ag. ^{in div'g & distribut'g wtr} in some of the most complex networks of
 relationships imaginable.

In respect to interstate relations, Calif. is the major single contestant in
 the greatest ^{interstate} water suit of all times, the Colo. R case; & at the same time
 offers the contrast of ~~a~~ the only really large-scale water project which is
 without interstate complications

In respect to techniques, Cal. has wide areas served by pump's ground wtr;
 others from ^{unreg.} surface wtr: still others from ~~stored~~ reservoirs; & many served by all
 3 at once. ^{It has ~~var.~~ reservoirs in the mts, & others in large shallow lakes on the valley floor.}
^{It has ~~lands~~ ^{distribution systems ranging from} served by natural flood ~~gutter~~ to 100% steel pipe under}
 pressure ^{to each burrows} — and these within a few miles of each other. It has simple single purpose
^{diversion projects} & the most complex multipurpose integrated projects to be found outside
 the USSR.
 Has wtr too saline to use & others so pure they must be ^{salinized} salted ^{let them} to permeate the soil.
 There are few midwestern conditions without their counterparts somewhere in the
 enormous diversity of Calif.

5. ~~4.~~ Calif. vit. matters are ~~probably~~ better reported than those of any other state. Calif. State govt., & her educational instns., are far more generously supported than those of other and states, so that ^{primary} ~~basic~~ data are available for research in greater volume. ~~than~~ ~~In the 1920s~~ from the Alexander Rpt. of 1874 thru the Marshall Plan of the 1920s & the State War Plan of today. Calif. has spent millions to gather vital data on the CV. alone.

~~4.~~ join with #2, time-aspect of volume.

4. Calif. imm. is still expanding rapidly - immo. on an absolute basis, ~~Retention~~ than imm. in other states - so that developmental problems are not just historical but current.

6. A study of imm. instns. in Cal. has already been well advanced from other funds, and ~~needs~~ would yield good returns to "supplemental imm." now.

Previous Work

in a few lines

While it is impossible, to give much idea of the scope of two years' ~~work~~ work, the following statement of

1. Analyzed ^{from a viewpoint} elements of Cal. w to law, ^{both a priori & from field exper.} identified major ^{unqs.} elements. ~~later~~
List of some ~~of~~ thirty to fifty significant types of diseconomies has been compiled
(the exact no. depending on how one organizes the material)

2.

*Project Statement for annual experiment station
report*

Oct. 23, 1959

Major objectives include a systematic analysis of present institutional controls over water use, comparing them with an economical and feasible system developed to include transferability; equimarginal distribution based on current demands and techniques; minimization and optimal distribution of risks inherent in variable stream flows; integration of ground and surface waters in one common market; application of principles developed to specific analyses of watershed programs, legislation, allocation of water among competing uses, and other water problems.

Major accomplishments ~~to be~~ include: developing and applying methods of analyzing variability of flows in order to estimate potential reductions of variability through conjunctive development; developing and applying a workable method to determine the stage of returns reached by storage capacity on ~~the~~ variable streams; developing and applying methods to determine the marginal productivity of water, both points and schedules; working out a system of pricing to optimize the use of water and developmental works through time, and ~~the~~ determining how best to approximate it within prevailing institutional constraints; ~~the~~ progressing towards solutions to the universal problems of making commensurable alternative and ~~complementary~~ outputs, including intangible recreational and esthetic values of lands and waters, and developing methods to define and evaluate complementary and conflicting relationships among outputs, both on and among sites, both in and among firms, both technological and pecuniary.

Future plans give top priority to final ^{organization and} exposition of materials now developed, including incidental terminal statistical adjustments; application of conclusions to recommendations for action in humid areas; proceeding with projected study of multiple-purpose land and water development in the Ozarks, with emphasis on maximization of joint net benefits through analysis of complex interdependencies facilitated by modern analytical techniques and mechanical computers; and clearing ground for study of interstate and State-Federal relations on the Missouri and Mississippi River systems.

to date

Tentative conclusions ^{to date} include the following:

1. The aggregate variability of water supply in a system is most significantly measured by the variance/mean, ^{and} which is minimized by a simple fractional division among water-users. Prevailing systems ~~raise~~ raise variability high above this ~~possible~~ attainable minimum.

3. There is a large costly excess capacity in aqueducts, due to (1), ~~the~~ above, plus the premium placed by water law on premature inflated claims; failure to rationalize independent agencies into integrated networks; and uneconomical scattering of water-users, which ^{once imposed} is perpetuated by rigidities in water law.

4. This excess diversion capacity, and commensurately inflated water rights/expressed in constant rates of flow, immobilize much water that is not actually used, forestalling further development of the most economical supplies. This creates artificial local scarcities which in turn lead to costly developments of remote supplies, such as the

Feather River Project, which is premature and necessitated only by underdevelopment of more ^{southerly} supplies.

5. In some areas water shortage is the limiting factor on economic development. These areas lie intermingled with others which could spare large water inputs without reducing output much or at all. Several areas could increase output by using less water. But controlling institutions are not adequate to permit exchanges to effect an economical equimarginal allocation.

6. Pump irrigators are widely scattered among unirrigated lands. This increases the cost ^{& volume of water necessary to} of recharging ~~any~~ underground water reservoirs and creates a large area receiving potential but unused benefits from recharge, thereby complicating the problems of organization, taxation, forecasting demands, etc., ^{and compels development to proceed, if at all, by large increments, with all the problems that implies.}

7. The marginal productivity of ~~reservoirs~~ storage works on different streams is very unequal, betraying an uneconomical unbalance of development.

(2) Diversions by holders of the strongest water rights tend to vary inversely with stream flows; diversions by holders of the weakest rights, ^{on the other hand,} are even more variable than the flows of wasted flood waters, a gross diseconomy.

8. The correlation among variable stream flows is the greater, the more equal their mean flows, so that mutual cancellation of flow variations is more to be achieved through integration of adjacent streams of different sizes than of remote streams of comparable sizes.

over
9. The ~~stereotyped~~ idea that cities widely circulated idea that the MP of water is much higher in cities than agriculture, while not w/o some merit, is by no means fully true: the major cities all have surplus water tied up for future needs, while many farm areas ~~are~~ could put it to production use.

(6) ~~to~~. Unit costs of w & d are inflated by failure to develop lands compactly, and by the ~~the~~ poor synchronization of devmt of complements.

~~the~~ Scattered settlement tends to become frozen into a permanent pattern when the limits of available w & d supply are reached.

October 7, 1959

To: Project Leaders

Subject: Statement on Projects for Annual Experiment
Station Report

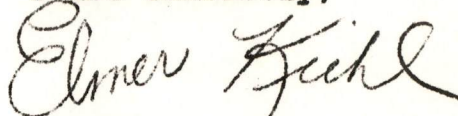
Gentlemen:

We have been requested to furnish a statement on each project for the year ending June 30, 1959 to be used in preparing the Annual Experiment Station report.

Attached is the general outline form of the statement. Note that a maximum limit is two pages double space. I would suggest that you review your progress report statements submitted in March. I believe these will provide the essential information. You, of course, can add, restate, and bring up to date (to June 30, 1959) within the two page limit.

Through neglect on my part these reports are overdue. Could we have them by Wednesday, October 14 so that Clyde Duncan can proceed with getting the report to press.

Yours sincerely,



Elmer R. Kiehl
Chairman

ERK:cl
Enclosure

1. Project 363; Economics of Water Resource Utilization.
Number Short Title

2. Personnel connected with project:

M. Mason Gaffney

3. Objectives of project:

4: Highlights of study, what has been accomplished to date and what is contemplated in the future.

5. Conclusions, if any, (Stress practicability of the study).

The above to be placed on no more than 2 pages, double spaced.
Two (2) copies are required by editor's office. You may want to retain one for your files.

I. ~~Good Urban~~ Justification

No. ~~the~~ beginning process of shaping new wth law.

HRes. 57, 68th Genl Ass., resolved thorough study law of other states. Wisely, my opinion. Wise. plunged ahead, system invalidated. Other errors cd. be even more costly -- irreversible, vested interests.

Cal. selected ff. reasons:

- a. Parallel evolution
- b. Volume of exp. greater
- c. Variety greater - in re ~~data~~ products; phys. condns; instns;
urban-rural relations; interstate relations; techniques
- d. Better reported primary data.
- e. Study well advanced from other funds

II. ~~Plan of~~ Procedures

Analyze law a priori. List of diseconomies. ... glaring.

But many allege no problems in practise

So analyze practise. Californians have amassed much material, but mostly for courts, or propaganda. Room for objective outside appraisal.

Set up standards of performance

Keep identifying new problems: Guggenheim, NCT-44

UNIVERSITY OF MISSOURI
Agricultural Experiment Station
PROGRESS REPORT

for the year ending
January 31, 1960



DEPARTMENT Agr. Economics
FED. FUND Hatch
PROJECT NO. 363

4 copies needed: 1 - Project Leader
1 - Department chairman
2 - Director's Office

1. Title of Project

Economics of Water Resource-Utilization

2. Advisory Departments and Agencies

3. Cooperating Departments and Agencies. List Number and Short Title of Major Projects in Cooperating Departments and Agencies.

4. Names and titles of persons working on project.
Gaffney, M. Mason, Associate Professor

Use Additional Sheets for the following items 5, 6, & 7

5. List and ABSTRACT Publications Issued or Manuscripts Prepared During the Year (Include Bulletins, Circulars, Articles for Scientific Journals and Periodicals).
6. List by letter (A, B, C, etc.) the objectives included in this report.
7. Report of Progress including DETAILED RESULTS. If Available, Good Pictures showing results should be included.

APPROVED

M. Gaffney

Project Leader

DATE

March 14, 1960

APPROVED

Elmer R. Kiehl
Chairman of Department

DATE

March 14, 1960

5. Publications and Manuscripts

a. Completed and circulated summary of needed research in water economics and law in the midwest region (attached).

b. Accepted invitation to contribute chapter to forthcoming book on "Land, Agriculture, and Economic Development," edited by Richard Lindholm. Commenced work on chapter, which emphasizes role of water resource development in agriculture, historically contemplated.

c. A MS is being prepared on the topic "A critical economic evaluation of institutional controls over water development and allocation."

d. Accepted invitation to deliver address, to be published in symposium form after broadcast over radio KPFA, on "Criteria for the assumption of financial responsibility in water development." Commenced work on contribution.

e. Accepted invitation to discuss papers on "Rural-urban competition for water" at summer meetings of A.F.E.A. Commenced work on paper.

f. Continued work on article, "Concepts of financial maturity," by invitation of University of Chicago JOURNAL OF BUSINESS.

g. Revised MS on the theory of allocation of land. (This is not directly related to water resources, except as it applies to all perpetuities.)

6. Objectives included

A & B

7. Progress Report

In response to the opinion expressed at last year's SESD conference an effort was made to scale down those aspects of Project 363 which emphasized out-of-state local situations. The project was replanned, telescoping research in the arid states and accelerating those aspects of the project wherein the experience of the arid states is brought directly to bear on the problem of developing an economical system of water institutions for Missouri. Drawing on the western experience, an outline was prepared of needed research in water economics in Missouri and the North Central Region, and circulated among members of the NCT-44 Regional Committee (copy attached.)

At the same time, an effort was made to secure supplemental funds from private foundations to pursue the project as originally planned, a course which, in the opinion of the project leader, would be of more benefit to Missouri, and would avoid the waste of previous efforts devoted to collecting data and familiarizing the project leader with specific situation in the arid states. Applications were made to the Guggenheim and Lincoln Foundations; their outcome is at this writing still unknown.

The results of researches thus far finished were drawn together and summarized in the following ten tentative conclusions:

1. The aggregate variability of water supply in a system is most significantly measured by the variance/mean, and is minimized by a simple fractional division among water-users. Prevailing systems raise variability high above this attainable minimum.

2. Diversions by holders of the strongest water rights tend to vary inversely with stream flows; diversions by holders of the weakest rights are even more variable than the flows of wasted flood waters, a gross diseconomy.

3. There is a large costly excess capacity in aqueducts, due to (1), above, plus the premium placed by water law on premature inflated claims; failure to rationalize independent agencies into integrated networks; and uneconomical scattering of water-users, which once is imposed is perpetuated by rigidities in water law.

4. This excess diversion capacity, and commensurately inflated water rights expressed in constant rates of flow, immobilize much water that is not actually used, forestalling further development of the most economical supplies. This creates artificial local scarcities which in turn lead to costly developments of remote supplies such as the Feather River Project, which is premature and necessitated only by underdevelopment of more southerly supplies.

5. In some areas water shortage is the limiting factor on economic development. These areas lie intermingled with others which could spare large water inputs without reducing output much or at all. Several areas could increase output by using less water. But controlling institutions are not adequate to permit exchanges to effect an economical equimarginal allocation.

6. Pump irrigators are widely scattered among unirrigated lands. This increases the cost of recharging underground water reservoirs and creates a large area receiving potential but unused benefits from recharge, thereby complicating the problems of organization, taxation, forecasting demands, etc., and forces development to proceed, if at all, by large increments, with all the problems that implies.

7. The marginal productivity of storage works on different streams is very unequal, betraying an uneconomical unbalance of development.

8. The correlation among variable stream flows is the greater, the more equal their mean flows, so that mutual cancellation of flow variations is more to be achieved through integration of adjacent streams of different sizes than of remote streams of comparable sizes.

Data collection on out-of-state aspects of Project 363 was terminated with securing of minimal data on the following: salinity; irrigation withdrawals over time under several specific rights; temperature and precipitation in areas where correlations of crop output with water input are in progress; water supply to crops for which output data had already been assembled.

Having terminated data collection phases of the western studies, attention was focussed on processing data. It becomes evident that it was necessary to devote explicit attention to certain mathematical-statistical techniques. It was felt that research of this kind was necessary to draw valid inferences and derive the maximum value from data, from whatever area the data happened to come, and so the techniques developed are as valuable to Missouri as though the data being processed was drawn from within the state.

Some of the techniques developed were the following:

1. Workable means for estimating the marginal productivity of water applied to agriculture. The following methods were tested and compared: historical regressions of crop output and water input land prices with and with-

-4-

out water supply; the margin of willingness to incur variable costs to secure or conserve water (the fixed costs are distorted by several factors;); analysis of farm budgets; sale prices for water, where it passes through the market; controlled experiments on physiological response of crops to water; comparisons among farms and regions with different water inputs.

2. Analysis of variability in water supply systems. Comparing different measures of variability, and determining what expression of variability policy-makers should seek to minimize under different conditions; determining the most economical division of the burden of variability among different water users, both those of the same kind, such as farmers, and different kinds, such as power users and recreationists; defining the costs of variability, e.g. the excess capacity necessitated, and conversely the productivity of measures taken to reduce it.

Devising means of flexible pricing, and other flexible rationing devices, to balance unpredictably fluctuating water supply and demand and minimize the need for storage capacity.

Defining the marginal productivity of storage capacity on unpredictably variable streams, for purposes of guiding project design, and to put operational values on marginal productivity based on probabilities inferred from brief historical records which constitute a small non-random sample of geological experience.

3. Establishment of economic commensurability among different kinds of outputs from water projects. Determining rates of exchange among points of time, in order to judge among benefits and costs differently distributed in time. Defining external diseconomies and economies both technological and pecuniary ("secondary benefits.")

4. The problem of staging and synchronizing the development of complementary aspects of projects over time, with special emphasis on the problem of accommodating the new to the old without emphasis on the problem of integrating existing obsolete structures into newer systems with a minimum waste of unexhausted values in the old and a minimum distortion of economic layout of the new. The use of flexible marginal cost pricing, varying over time to effect a continual optimal utilization of durable facilities through their life-spans.

In addition to developing these techniques, statistical operations were performed as follows:

1. Completed analysis of variability of Kaweah River and distributaries.

2. Analyzed timing of flood stages on several rivers to determine possible increases of flood protection from given expenditures by co-ordination of operation of different reservoirs etc.

3. Continued to process data on historical correlation of crop output and water input. This phase of the studies has been particularly rewarding and informative, there being clear evidence of marked negative relationships between the two variables in many areas, suggesting extremely wasteful economy of water.

4. Historical correlation of reservoir operations

5. Compared use of water per acre under different water rights as to gross amount, distribution through time, and variability.

Much time was also devoted to planning and developing an interdisciplinary study of water conservation and multipurpose water development in the Osark area, in cooperation with Forestry, Soils, Wildlife Management, and Rural Sociology. Substantial progress was made in the use of economic concepts as means of communication and arbitration among other disciplines.

Emphasis was on establishing a basis of commensurability among costs and benefits of alternative land uses; and on means for maximizing complementation and minimizing conflicts among them, both on and among sites, both in and among firms, both technologically and pecuniary ("secondary benefits.")

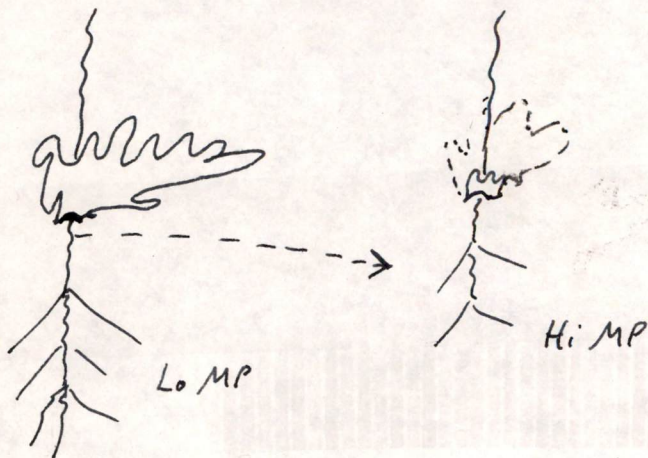
The problems of coordinating related activities on a large scale; of staging and synchronizing their growth; and of superimposing new technology, institutions, and transportation and utility networks on existing ones with a minimum of waste were identified as crucial to development, and approaches to their solution in the Ozark area were formulated.

Unhappily this work was set back by the departure of the two cooperating foresters for other employment.

In cooperation with John Krutilla of RESOURCES FOR THE FUTURE, INC., a study was made of the proposed Water Rights Settlement Act and its background in Federal-State relations.

It was felt that the stage had been reached where some time might be devoted to exposition of work already accomplished, and this task was commenced. It was determined to take advantage of three invitations to publish (see item 5) as a basis for selecting materials for initial exposition. In addition some work was accomplished on the major study: e.g. the work on water law was summed up in a list of some thirty diseconomies inherent in water law as applied in the western states.

It was also necessary, finally, to carry on various necessary incidental activities: attending meetings of Missouri Basin Research and Development Council; consulting upon request with those engaged in related research; reviewing manuscripts; following current literature in the field; picking up needed background for handling problems in mathematics and statistics and programming the electronic computer; scanning literature in related field seeking techniques already worked out by others that might bear on our problems. An especial effort was made to attract fellowship funds to attract promising students to carry forward work in this area, and these efforts were crowned with success.



2 alternative solutions: xfr; new storage

Wtr law may block both.

It is not always too little xfr of wth
that is problem.

Xfr from remote area is too easy
relative to devmt of local supplies.

Unevenness of xfrability is problem.

Obstacles to xfr preclude small adjustments,
for a large ones.

To overcome limitations of ripson,
Cal used MWCs & IDs.

Now Mo. moving to RBCDs.

Value of Calif. study:

means of mrg productivity of
water -
analytical techniques.

Calif. precedent useful.
Re modifying rip. rts.
Cannot just pass law &
proceed as tho they didn't
exist, as Wisc. found.

Calif. limited them by
defining them. Courts have
gone along with that.

Methods of relating water input to
crop output, a prime subject
of study now.

Effort in '59 - to
salvage what cd. from western
studies for appln in No.

Gurly, encourage Fred Mann
to assume interests in Mo. water.

This leaves me free to work in that
if I wish, but insures against
my being forced into it.

Contemplated in future.

Perfect clustering of deficits index.

A. Minor & stat. work

1. ~~Analy~~ ~~Analyze~~ joint variance of ~~several~~ a few key streams for which data not previously available

1. Estimate net benefits possible from joint development of 2 or more streams (as means of assessing importance of the water law that obstructs it.)

A. Analyze joint variance of more likely streams, for which data not previously available.

B. Find times of peak demand for storage, possibilities of minimizing total capacity by joint full devmt.

B.

2. Compute variances and Lorentz ratios for distribn of water among diff. lands, as means for expressing systematically the inequality of wtr distribn

3. ~~Off~~ Using method of (2), see if ~~areas where water is~~ pricing water, where this has been done, tends to reduce disparity of per acre use.

4. ~~New~~ index of seasonal variation: corr. given yrs, monthly ^(or daily) flows. ~~with ave. monthly (or daily) flows.~~ No -

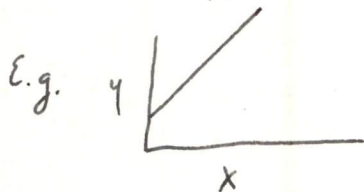
4. Effect of priorities system on forecastability of flows.

5. Demonstrate ~~the~~ in quantitative form the scattering of ind bms among dry bms.

6. Refine correlations of output & wtr input for a, wx; b, seasonal variations of water input.

Future Plans, 2

7. Analyze seasonal patterns of diversions and flows, water-rich & water-poor areas, as index to other MPs of water.
8. Draw up lessons for Mo. from Cal. experience.
9. Study network analysis by power cos., possibilities for economies in irrm. nets.
10. Explore further possible benefits from integration.
Use 90° variation rather than absolute (perhaps work out new kind of ρ).



Here is perfect correlation; and similar σ_s . But x goes down to zero, has lower ~~σ~~ mean. Its $\frac{\sigma}{x}$ is greater. Also $\frac{\sigma^2}{x}$, my favorite measure.

Integration might help x more than hurt y .

11. Correlate 5-yr blocs (or so) of CV streams.
Maybe big cycles differ more, & hi ρ are due to yr-to-yr. correspondence.
12. Add salinity of water to analysis: benefits of integration on.
13. Develop mathematical-statistical techniques ~~for~~ needed to determine optimal economic adaptations, both individual and social, to variable water & other weather-related inputs.

Future plans, 3

B. Draw inferences for eastern conditions - including methods developed.

C. Proceed with study of multiple use ees. in Ozarks.

Plans, write on wtr, book. ^{As plan is putting out long study as less but in degree but. proceed on more central then.} (For ideas, see Ore. course notes; Ford project outline; files) ^{at managing}
~~Importance of wtr. -- (incidentally, suggest value of wtr). Lim. rational. Impute all loss to wtr~~
over ~~List of wtr law -- very briefly.~~ (Sub-theme: some econ states think change to approp. is answer)

Major defects -- ~~Examples~~ a priori, then some e.g.s., obvious ones
(Introduce = moral criterion)

? { Approaches toward more econ. systems -- (push back limits of econ. growth imposed by ~~limitational~~ wtr)

So analyzing wtr would be good to expand p.u. systems? ^{MP wtr vary among users & places, by more + more conveyance costs}
~~Rough est. how much to be gained by reallocating wtr -- some more careful studies ex.~~
~~So gain~~

Remains problem of defining ideal econ. system. (Al + ho ~~the~~ defects of present system are clear on basis of elementary principles alone)
~~ideal pricing distrib. net.~~

• 1 facig } w. atten to dynamic aspects: let prices evolve as needs change.

Econ. limit on aggreg. use, ⁱⁿ face of salinity & pollution pickup.

Storage policy in face of uncertainty.

Econ. pricing at central source with uncertainty.

Econ. scale, priority of works

Econ. rate of dev. & price-tax policies to effect it.

Econ. alloc. among diff. types outputs.

Est. how much might be gained by reallocating wtr. by ideal system.
(This must be done in parts, tho, otherwise are bring'g in many issues & not isolating effects of various individ. reforms)

Importance of studying wtr now - period of flux in wtr flow - decisions made now will probably be frozen for long time.
Some important ^{physical} peculiarities of the resource: Neglect by ecists

a. Peculiarities
Used both as input, & for waste disposal - deteriorates as proceeds down

Irregular unpredictable flows

^{Moves} Individual units not identifiable
+ cost conveyance of value... place utility $\therefore$ esp. input, & compact settlement.

Flows downhill free ... elevation $\therefore$ input part of value, 3-d problem.

Store underground - mine, & replace
(Mystical attitudes)

b. Similarities.

Is stored, & distrib. over network

Fungible, but quality varies.

Is problem of allocat'g inv. between dev'g wtr, & complement'g it
once developed, leads to cycles. Lag leads to ~~ex~~ relative overdev.
wtr -- of which research in desaliniz'n is one e.g.; FRP another

Further justification of out of
State study: can see issues objectively,
divorced from local political pressures.

E.g. pro & con central control &
coordination. On Mo. is a local
issue, limits objectivity.

As early as 1873

Efforts ^{by State} to dev. a comprehensive plan for
whole ~~State~~ CV date back to 1873, when

Bd of Commrs prepared rpt on irri in CV;
(Source - CVP blurb)
& H. Miller's Orestimba Canal, — miles

long, dates from — .

Info for NCT-44 proj. outline.

Not only field practice, but practice of WRB., which has wide discretion where law vague, modify law.

Cal. has, '49, new Dickey Act, 9 regional water pollution control bds. Distinguishes 2 concepts, "Contamination", which is a threat to health, & "pollution", which has adverse econ. effects. The 9 regional boards are charged with latter.

Return irr. wr. is included as an "industrial waste," along with detritus from earth denuded by logging;

Polluting a good aquifer via a well joining it to a bad one is also included. - Moskowitz p. 17.

Here again it seems to me Cal. has taken lead. And certainly in terms of experience, reuse of wr., data on pollution, etc., way ahead.

Land Subsidence

There is a "Committee on the E. of W. Res. Devmt." of the W.-n. Ag. Ex. Res. Council which is a regional committee, U.S.D.A. financed.

Recirculation of water at Fontana.

On history of irr. under Padres see Hutchins, "The Community Acequia",

SW Hist. Q. 31 (3): 261-84 (1928)

Info for NCT-44 project outline.

Forecasts of doom from drought commenced long before actual need.
1920, e.g., trouble was foreseen, but agric. expanded anyway — I think.

Nordholm 2, p. 6 —

1954, c. 5 m a irod in 18 Valley-floor Cities

1950, 4.2 m a irod in Valley

1950, 4.2 m a = .16 all irod land U.S. = .16 x 26.3 m a

But is more intensive than all U.S. doubtless

of the 4.2 m a, 3.5 were cropland, .7 pasture.

Get gross output value, cf. vs. U.S. on that basis.

Was it Calif. in genl or irod in particular that destroyed Eastern horticulture? Decline of dry farmed orchards in Calif. suggests latter.

p. 41 1953, Total cash farm inc. Cal = \$2.6 b

Not just land of fruits & nuts. .9 of above from livestock & products.

Probably no State ever came so close to adopting "muni. socialism" at the State level. 1922 Water & Power Act, constl. amendt backed by leaders of State, wd. hv. created State-owned ~~for~~ multi-purpose system.

3 large leagues of cooperating cities drawing water from afar.

Recent Wis. ruling in the Nekoosa-Edwards Paper Co. case points up that ~~the~~ humid States cannot avoid troubles, cannot simply forge ahead as the preexisting ripn. system never existed

Info for NCT-44 project outline.

? ^{Wealth of primary data} ~~esply well studied~~. CVP, battles among giants - Cal, BR, AE, PGE — produced many well-fused studies. State is far ahead anyway, well-known liberality of legislature in fring research. But lacking objective outside appraisal.

Use of lakes on flatland for irr. resers. - Tulare, Buena Vista.

Drainage & flood control problems

Transition — have bn many in Cal, dynamic evolution. Hence relevance to humid problems.

1776, Spanish missions began irr.

1850-70, flooding type irr by individ

1870s, cooptive projects begin. — & land devmt cos; port cos.

Use of groundwater from 1890, regn of land gradually evolving.

Irrd fm land in Cal, (Nordholm 2, p.11)

1880 - ⁴ ~~2~~ m a

1890 - 1.0

1900 - 1.4

'10 - 2.7

'20 - 4.2

'30 - 3.6

'40 - 4.3

'50 - 6.5

Did Dir. of W.R. or someone doctor figures to suggest land went out of irr. over 1920s? Or is picture distorted by selection of decennial years to of?

Info for NCT-44 contrib. project outline.

Ks. has had battle of ripn vs. appn. to recent times, too.
But her appropn statute goes back to 1886. And the 1945 Supr. Ct. Decision reasserting ripnism was quickly reversed by '46 statute. And never went thru such evolution as Cal., limited in various ways.

In Ts., ripn. & approp. doctrines grew up together.

Wn. like Calif.; gradual attenuation of ripn sts.

S.T. Harding sup, p. 56, no w. State uses rip. sts as much as Calif.

Cal has 100s of MWCos.

1970 Census gives no. of firm enterprises of diff. kinds. Cf. Cal. vs U.S. (1930 in Hutchins p. 16)
Only Utah besides Cal has MWCs - & Utah lacks other things.

✓ Historically, MWC was means for separating rip. st. from rip. land, when subdivided. Hutchins, MWCs, p. 208. Cf. Life of Chaffey. Thus Cal. is place where best study this particular adaptation to ripn. doctrine. - including xfr by sale of shares.

CV has experience in superimposing more intensive culture over less, several stages, with oppn - from dry farmer. from irtr. w. other sources. Plain States have same (but not other things)

Cal. has areas of wtr law where first comers have all; & others, correlatin sts, where early users have no pref. over later ones.

Cal. has much experience w. conscious use of grnd resr for wtr mgmt, regulation of its use.

IDs, some operating complete self contained multipurpose systems, storij wtr, genitg & distig own power; to simple retailers.

Literature pertinent to proposed research in land and water economics.

I. There is so much literature on water law it is impossible to begin to suggest its scope. Law journals are filled with it. Legislative Reference Services in over half our States have published studies for their States within the last five years, so great is the interest. Wells Hutchins with the P.E.R.B. and C.E. Busby with S.C.S. have published a great deal from within the Federal service. Western economists such as Ciriacy-Wantrup at Berkeley, Herbert Snyder at Davis, and Roy Huffman at Montana are writing on this topic currently. Engineers such as Sidney T. Harding at Berkeley and Harold Conkling at Los Angeles have written useful contributions to the subject. Interested parties have not kept their opinions to themselves either, and there is no end of material from the National Reclamation Association, the Irrigation Districts Association, and so on.

Most of this literature tends to be fairly ~~timid and~~ limited in its approach, however. While it may be appropriate for most of the writers to limit themselves to what is politically feasible in the near future, it seems to me the place of the economic scientist to look at the present institutions in an entirely objective light and strive to describe institutions that might lead toward an optimal utilization of water. This would be my excuse for adding to the literature in this field. This approach would I believe not only fill an intellectual vacuum, but find a reception among "practical" politicians.

For my present research I am using primary data collected by the California Department of Water Resources; the U.S. Geological Survey; the Bureau of Reclamation; farm management experts in the State Experiment Station; the State pollution board; individual irrigation districts; county planning commissions; private utilities, industries, and large landholders and mutual water companies. And the U.S. Census (of Irrigation and Drainage).

There is also a new California Committee on Research in Water Resources, bringing together the research resources of the University system, and publishing a good deal of material. This is something I hope we can get started in Missouri, although of course we would have less cause to get into it than California on a large scale.

II. There is also a vast literature on the urban fringe. Perhaps I could begin by mentioning my chapter in the 1958 Yearbook of Agriculture on Urban Expansion. Political scientists, city and regional planners have probably done more work in this area than others. Two excellent examples are the Cuyahoga County Planning Commission's study of the water and sewer problem; and George Esser Jr.'s study of Greensboro, N.C., and its urban fringe -- this was sparked by a General Townsend, head of the N.C. Water Board, who has an especial interest in water supply.

The California State Water Resources Board in its Bulletin 2, WATER UTILIZATION AND REQUIREMENTS OF CALIFORNIA, has given especial attention to urban demands for both water and space, and brought out some interesting facts about population scatter in urban fringes, and

the high cost of water and sewer networks to serve such populations.

The current debate on agricultural zoning is producing some informative literature. I give especial weight to the work of Dr. Jack Lessinger in the Santa Clara Valley of California. Lessinger's work is just starting to come out. One article is to appear in LAND ECONOMICS next issue, and a longer study will be released through P.E.R.B. shortly.

It is a little hard to predict just where one will find solid, well-reasoned work in this field. In general I find that respectable and conventional sources such as the National Bureau have severe limitations, and I tend to be quite critical of the work they have sponsored by Leo Grebler, David Blank, Louis Winnick, et al., on urban real estate. The city and regional planning profession, too, seems to have developed a definite ideology that destroys much of the individuality of thought that makes for good research. And so one must scan work in many fields to find the rare individual who has appraised the problem probably through his own eyes and put his own stamp -- and a good one -- on his work. Two examples are the Geographer John R.P. Friedmann, whose THE SPATIAL STRUCTURE OF ECONOMIC DEVELOPMENT IN THE TENNESSEE VALLEY is a very competent work; the Sociologist Amos Hawley, who has done a great deal of work on urban real estate -- and I might add that not all of it is as good as the best, by any means; and the planning consultant Homer Hoyt, whose 100 YEARS OF LAND VALUES IN CHICAGO is a classic. B.

On the question of urban decadence, my thinking runs along the lines of Gerschenkron's principle of relative backwardness. I think of the city as an economic unit with a considerable potential for monopolistic exploitation of its hinterland, which often takes the form of underdevelopment and stagnation. Hekscher's mercantilistic mediaeval city is perhaps the implicit prototype.

On the question of urban expansion and economic instability, my effort is to integrate, or let me say bring together what is known of urban expansion to evaluate its impact on aggregate national income and employment. This is the burden of my Yearbook article or chapter. In addition to the ideas and relationships developed there, I have hopes that modern input-output techniques may be applied with a regional slant to throw more light on this problem of the dynamics of urban growth. Walter Isard is doing pioneer work in this field -- his study of the impact of steel on the New York - New Jersey area is often cited.

III. On interstate water problems, the Missouri Basin Survey Commission study, MISSOURI: LAND AND WATER, is a basic source. The presidential commission under Meyer Kestnbaum has done interesting work in the field of Federal-State relations. There are innumerable interstate river compacts to study. These have been assembled by Richard Witmer (ed), DOCUMENTS ON THE USE AND CONTROL OF THE WATERS OF INTERSTATE AND INTERNATIONAL STREAMS. (USDI, 1956). Besides the famous Colorado Compact, still the subject of a protracted lawsuit between Arizona and California, there are compacts on the Arkansas, Canadian, Connecticut, Ohio, Pecos, Potomac, Red, Republican, Rio Granda, Sabine, Snake, South Platte, and Yellowstone, among others.

The Hoover Commission has also expressed itself strongly on Federal-Local relations in water. The task force under Ben Moreell stated the policy recommendations, and Moreell has published his views separately in
OUR NATIONS WATER RESOURCES -- POLICIES AND POLITICS.

A group at Harvard is doing original work in the field of basin-wide watershed control, integrating the operational ideals with the political necessities. Maynard Hufschmidt leads the group. He has sent me some of the preliminary studies by Harold A. Thomas, Jr. Thomas is applying statistical techniques to interpretation of hydrologic data for economic planning. I would hope to maintain contact with this group.

The Duke University School of Law has devoted two recent issues of its journal, LAW AND CONTEMPORARY PROBLEMS, to "Water Resources" (Summer, 1957), and "River Basin Development" (Spring, 1957)

Other relevant works are Schulz, Wm. F. CONSERVATION LAW AND ADMINISTRATION, 1953 (emphasizing Pennsylvania); Leuchtenburg, Wm E., FLOOD CONTROL POLITICS - The Conn. R. Valley Problem, 1927-50; Smith, Lincoln, THE POWER POLICY OF MAINE.

IV. Plains economists have given considerable study to the problem of adapting to unpredictable precipitation. Some of the studies are Thair, Philip J., STABILIZING FARM INCOME AGAINST CROP YIELD FLUCTUATIONS, N.D. A.E.S. Bull. 362, 1950; Heisig, Carl P., "Income Stability in High-Risk Farm Areas," JFE, 11-46; Johnson, Sherman E. "Irrigation Policies and Programs in the Northern Great Plains Region," JFE 8-36; Huffman, Roy E., "Stabilizing Farm Economy Through Integrated Use of Irrigated Land.", THE MONTANA FARMER 1-47.

I have not kept up with more recent studies.

V. Several States are initiating programs to compile and distribute information useful to those concerned with water. California requires all well drillers in the southern counties to divulge their basic findings to a State office, and is probably going to extend the program to the entire State. North Carolina was on the verge of passing such a law when some legislators undertook to convert it into a tax-collecting device and it failed. A State employee pointed out to me that one of the Cola companies pushed through a State law forbidding the State to publish any information about the amount of water used in its plants.

In recent years there has been a wave of literature critical of our scientific secrecy-security programs and their destructive effects on intellectual stimulation and progress. I would exploit that literature to make a similar point about water information, and for that matter geological information of all kinds.

UNESCO is doing work in this field, too -- viz their recent study of TRADE BARRIERS TO KNOWLEDGE.

VI. There is a wide literature on watershed protection. The effort of my studies would be to apply an impartial judgement among the various viewpoints advanced. The Crusading spirit in this field has tended to lead to extreme statements and militant partisanship. I would try to determine just where the balance of advantage lies between for example soil treatment vs. big dams as storage reservoirs.

VII. A definitive work in benefits-cost analysis is the Federal Inter-Agency River Basin Committee "Green Book", PROPOSED PRACTISES FOR ECONOMIC ANALYSIS OF RIVER BASIN PROJECTS, and its successors. A recent effort is a Stanford Research Institute publication by Charles Hammans, but I am told it adds little to the Green Book.

The problem of secondary benefits has not to my knowledge received any definitive treatment. That indeed is a major reason I would propose to work on the topic. It is of very high interest, and the demand for work in this field would be great. Last week the economics director of the California Department of Water Resources advised me that he would most like to see study in this field.

A forthcoming work by John Krutilla and Otto Eckstein will contain chapters on this topic, but from preliminary conversations I have concluded that they do not have an adequate solution to the question.

VIII. Studies of scale of farming are legion. The conceptual framework of such studies has become practically uniform, and I tend to be very critical of the "party line." Bachmann, ~~McIlvaine~~, McElween, Heady, and Schultz, and Johnson are all open to fundamental criticism.

IX. Again, I know of little work that has come to grips with what I conceive to be the most interesting and portentous issues here. I would work from primary data to try to get some measure of the extent to which Federal income taxes tend to divert human motivations from their most economical expression.

X. I am not as familiar as I would like with technical literature in the field of education. Thus far my ideas on this topic spring largely from personal experiences, and observations.